WSMCR 127-1

WESTERN SPACE AND MISSILE CENTER

RANGE SAFETY REQUIREMENTS

RANGE SAFETY REGULATION

15 MAY 1985

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FOREWORD

Safety, in the context of this regulation, implies a concerted effort by the users of the Western Space and Missile Center (WSMC) to operate in a manner that will minimize in every way possible the inherent danger in missile operations. This document brings to the Center user the safety requirements and procedures established by this Center.

It is our desire and purpose to assist you in any way so that you can best meet both your program objectives and the range safety requirements. Because of the great complexity of present space programs, and the inevitable cost of changes in hardware and time schedules, I cannot emphasize strongly enough the importance of meeting with the WSMC Director of Safety early in the planning stages. This will ensure the earliest launch approval and the optimum in planning from a safety standpoint.

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WSMC REGULATION 127-1
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Safety

RANGE SAFETY REQUIREMENTS

This regulation establishes Western Space and Missile Center (WSMC) range safety policy and defines requirements and procedures for obtaining Range Safety approval for missile operations on the Range. It applies to all Range users at or supported by the WSMC, to units using the services of, or providing services to the WSMC, and to national agencies whose vehicles impact into the Western Test Range (WTR).

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Chapter 1

WSMC SAFETY POLICY

1.1. Policy Introduction. WSMC WTR is designated a National Range by Department of Defense Directive (DODD) 3200.11. The directive includes safety as an intrinsic part of the Range Commander's responsibility to support the facility user. The WSMC Commander (CC) is the final authority for safety at the WTR, and only the Commander's designated representative has the authority for granting waivers or changes to this regulation.

1.2. Facility User. The facility user is any military and civilian organization or Federal Government agency that requires the use of WSMC facilities, including any foreign or domestic organization sponsored by a US Government agency.

1.3. Safety Objectives. The WSMC/CC's objective is to make sure all programs using WSMC facilities are within acceptable risk limits consistent with mission requirements and national needs. This regulation provides specific requirements, criteria, and guidance to protect personnel from inordinate risk, injury, illness, and property from loss or damage due to WSMC operations. To achieve an efficient, effective safety program, potential safety problems must be identified, evaluated, and either eliminated or controlled as early as possible in the system acquisition process and throughout the system life cycle.

1.4. Prior Program Approval. Systems, subsystems, operations, and procedures approved prior to the date of this regulation remain approved and do not need to meet these new requirements unless the WSMC Directorate of Safety (SE) and the user jointly determine that:

1.4.1. It is economically and technically feasible to incorporate the later requirements into the system.

1.4.2. The system is modified or changed so much that the existing safety approval no longer applies.

1.4.3. A previously unforeseen safety hazard exists.

1.4.4. The system does not meet the requirements as originally accepted.

1.4.5. Established waivers will remain in effect until the new requirements are applied.

1.5. Safety Review Team (SRT) Concept. Safety participation during the initial system design period reduces costly engineering changes at a later date, so contact must be established with WSMC/SE as early in the system design period as possible. WSMC/SE will determine the necessary disciplines within the directorate to support the SRT. WSMC/SE will be notified of all technical interchanges (TI), system design reviews (SDR), preliminary design reviews (PDR), critical design reviews (CDR), and safety reviews, and is represented at meetings that could affect WSMC (paragraphs 3.2.3 and 4.2.1). All design information must be provided to WSMC/SE at least 30 days prior to the design reviews.

1.6. Safety Approval. The user has the basic responsibility for compliance with WSMC/SE directives. The organization must demonstrate compliance with WSMC requirements prior to requesting approval. Mandatory approvals are:

1.6.1. Statement of Program Acceptance (SPA). Used for flight and ground safety conceptual concurrence.

1.6.2. Flight Plan Approval (FPA). Must be obtained prior to Range acceptance of a launch commitment. Proposed plans and supporting data are submitted as outlined in chapter 2.

1.6.3. Missile Systems Ground Safety Approval (MSGSA). WSMC/SE approves all airborne systems and their associated ground facilities, and all subsequent modifications used on the WTR (chapter 3).

1.6.4. Flight Termination System Approval (FTSA). Must be obtained according to the requirements outlined in chapter 4.

1.6.5. Operation Approval Letter (OAL). Acknowledges preliminary approval for an operation involving a particular vehicle within specific constraints. Final approval is executed when the Range transmits a green status and alert indication to the Range user launch control authority late in the launch day countdown.

1.7. Safety Waivers. When a waiver is necessary, the formal request must include a justification, supported by a technical study. A waiver is granted if the mission objectives are considered of sufficient importance to justify the added risk, or when compliance with a requirement would impose an unreasonable cost. The WSMC/SE policy avoids using waivers except in extremely rare situations.

1.8. Flight Termination System. All missile and space vehicles flown on the WTR must be equipped with a flight termination system according to the requirements of chapter 4. Depending on the program mission, the flight terminating capability must be sustained until a safe, final impact point is established, or orbital injection occurs. Small rockets, as defined in paragraph 2.6, are excluded from this requirement. Flight termination action may be taken if:

1.8.1. Abort line violation is apparent according to the data presented to the MFCO. The abort lines are determined from the data provided in response to chapter 2.

1.8.2. Obvious erratic flight that may result in loss of flight termination control.

1.8.3. Performance of the vehicle is unknown and the potential to violate abort lines exists.

1.9. Tracking Aids and Missile Performance Data:

1.9.1. Tracking Transponder System. All missile and space vehicles flown on the WTR must be equipped with a tracking transponder system according to the requirements of chapter 4.

1.9.2. Telemetry Data. All missile and space vehicles flown on the WTR must provide the following telemetry data for missile flight safety use:

1.9.2.1. Telemetry Inertial Guidance (TMIG) data for all inertially guided vehicles (paragraphs 2.4.1.15.1. and 2.4.2.15.3).

1.9.2.2. Missile performance and flight termination system data (paragraphs 2.4.1.15.2, 4.3.7.1. and 4.3.7.2.).

1.10. Impact Restrictions:

1.10.1. Missile, space vehicle, payload, reentry vehicle, or jettisoned component impact dispersion areas are not to intentionally encompass land, unless designated as a target. The Range user is responsible for ensuring that all impacting hardware will either sink or be recovered.

1.10.2. For stages that contain engines having a multiple burn capability, the impact dispersion area, corresponding to any planned cutoff prior to orbital injection, must be entirely over water. Trajectories must also be shaped so impact dispersion areas are entirely over water at times of other critical discrete events such as arming of engine cutoff circuits and backup engine cutoff commands.

1.11. Safety Holds. A directive to either prevent an operation from starting or stopping an operation already underway. Safety holds may be called if: safety criteria cannot be assured or maintained; safety criteria are being violated; personnel and equipment are or will be unduly jeopardized; or an imminently dangerous situation exists. Safety holds may be called by Range Safety representatives, or by responsible supervisors in charge of an operation. Each launch system must have the following capabilities provided for range safety in the event of unsafe range conditions or loss of critical range safety systems:

1.11.1. Each launch system must have a "hold-fire" capability that will stop the launch sequencer (paragraph 4.3.8.3.1.11).

1.11.2. Each launch system must have an inhibit of the ignition firing line (MIL-STD 1574A).

1.12. Host Tenant Agreement. The 1st Strategic Aerospace Division (1 STRAD), Strategic Air Command (SAC), is the host organization and is responsible for all missile ground safety at Vandenberg AFB (VAFB), as described in 1 STRADR 127-200, Missile Mishap Prevention. Missile ground safety authority for all Air Force Systems Command (AFSC) facilities and operations at VAFB is delegated to the WSMC/CC by AFR 11-4, Host-Tenant Agreement. In addition, the WSMC/CC is responsible for all WSMC facilities and operations at locations other than VAFB. WSMC/SE is responsible for establishing and monitoring the Commander's Missile Ground Safety Program at VAFB and all other WSMC locations.

1.13. Senior Missile Flight Control Officer (SMFCO). The WSMC/CC has final authority and responsibility for missile flight safety from launch through impact or orbital insertion. During countdown and flight the SMFCO directs flight safety operations as the direct representative of the WSMC/CC.

1.14. Orbital and Recovery Operations. The agency controlling orbital, deorbit, and recovery operations is responsible for the safety of persons and property during such operations.

1.15. Manned Vehicle. The vehicle commander is responsible for preventing unacceptable hazards to life and property during the time the pilot has flight control. Significant risks to the general public are not allowed solely because the vehicle is manned.

1.16. Range User and Supporting Agencies Responsibilities. The range user and supporting agencies are responsible for:

1.16.1. Compliance with the requirements of this regulation.

1.16.2. Coordinating system safety measures with the Range to include changes in the design or operation.

1.16.3. Investigation of safety incidents or anomalies.

1.16.4. Crew safety for manned systems.

Chapter 2

FLIGHT ANALYSIS

2.1. Flight Analysis Introduction. This chapter sets forth requirements the Range user must meet before conducting a mission or flight test at the WTR. It establishes detailed data requirements pertaining to the trajectory and flight characteristics of the following types of test items or missions:

2.1.1. Surface or air launched ballistic missiles and space vehicles.

2.1.2. Cruise missiles.

2.1.3. Surface or air launched small rockets.

2.1.4. Nonpropulsive objects dropped from aircraft.

2.1.5. Aircraft and ship sensor support.

2.1.6 Aircraft and aeronautical systems.

These requirements are designed to provide the Range with the basic data to analyze each mission for flight safety and to prepare all safety criteria in support of the mission.

2.2. Flight Safety Approvals:

2.2.1. It is the intent of WSMC/SE to issue a Statement of Program Acceptance (SPA) as early as possible to assure the Range user that the specific test program is conceptually acceptable from a flight safety standpoint. For programs that are new to the Range, it is important that Flight Safety takes part in discussions with the Range user early in the conceptual phase of program development and missile design to make sure safety requirements are understood and included in the overall system design. The WSMC/SE goal is to assure that all, or most, of the program objectives are satisfied without compromising safety.

2.2.1.1. Approval of the SPA is obtained in direct discussions with WSMC/SE during the early development phase of a program to assure an understanding of safety requirements and design constraints. When Flight Safety is satisfied the airborne safety system and general mission scenarios meet requirements outlined in this regulation, the SPA will be issued. It is never too early to discuss program or mission plans with WSMC/SE. A SPA should be obtained during early preliminary design for new systems and definition of program objectives. Normally this should occur prior to, or shortly after, submission of program introduction (PI).

2.2.1.2. SPA is required for each program. The request for an SPA should be made very early in the conceptual phase of a new program. This is accomplished during interchange meetings with WSMC prior to program introduction. The following information is required:

2.2.1.2.1. Basic program objectives.

2.2.1.2.2. Booster and vehicle description.

2.2.1.2.3. If the airborne system is a new design, WSMC/SE needs to be involved to define the flight safety system.

2.2.1.2.4. Vehicle propellant characteristics (TNT equivalency, etc.).

2.2.1.2.5. Siting of launch facilities, other building locales, and information on each structure.

2.2.1.2.6. General program mission scenarios and proposed target areas, if known.

2.2.1.2.7. Preliminary trajectory data on magnetic tape and listed according to AFSCM 80-12, AFSC Standard Theoretical Trajectory Magnetic Tape Format.

2.2.1.2.8. Vehicle maximum turn capabilities.

2.2.1.2.9. Preliminary estimate of vehicle breakup characteristics due to destruct action and nominal target area (for ballistic programs) impact dispersion for all reentering bodies.

2.2.1.2.10 Maximum downrange and crossrange instantaneous impact point (IIP) rates throughout powered flight.

2.2.2. Flight Plan Approval (FPA) should be requested as soon as possible; however, flight safety requirements, both data and hardware, must be satisfied at the time of request. FPA should be obtained no later than mission targeting date. The latter should be followed by programs that require FPA issuance on a mission by mission basis.

2.2.2.1. The FPA is issued, upon request from the Range user, when WSMC/SE is satisfied that specific mission(s) for a given program can be supported within the limits of flight safety control capabilities to provide positive protection to life and property whenever possible. The FPA is based on detailed analysis of program objectives, vehicle performance, and other data items required by this regulation. The FPA identifies safety constraints for mission support and specific conditions of the approval. Any constraints or conditions identified in the SPA may be superseded by those stated in the FPA depending on circumstances. The FPA is final and remains in effect throughout the life of a program as long as missions remain within specific safety constraints.

2.2.2.2. When requesting FPA, the Range user provides the following information in writing to WSMC/SE: NOTE: Reference may be made to documentation previously submitted, where applicable. If specific data are not available, the best engineering estimate should be given.

2.2.2.2.1. Number and designation of launches the proposed flight plan applies to.

2.2.2.2.2. A statement indicating whether the proposed flight plan is similar to some prior mission.

2.2.2.2.3. Intended launch date(s).

2.2.2.2.4. Description of vehicle configuration, including the guidance and control system.

2.2.2.2.5. Payload description sufficient for hazard assessment (explosives, radioactive materials, high pressure vessels, etc.).

2.2.2.2.6. Description and location of destruct systems and inadvertent separation destruct devices, or statement that the proposed system is similar to one already in use.

2.2.2.2.7. Tracking aids, including their locations.

2.2.2.2.8. Type of propellants. If a vehicle has the capability of detonating as a result of self-initiation, destruct system activation, ground or water impact, data for blast damage assessment is required. The following data must be submitted:

2.2.2.2.8.1. TNT equivalency vs flight time of each separate stage, and each possible combination of stages that could result from malfunction conditions.

2.2.2.2.8.2. The probability of detonation vs flight time for each of the following: self-initiation, destruct system activation, and ground or water impact.

2.2.2.2.8.3. Description of methods used to minimize the possibility of detonation.

2.2.2.2.8.4. Time of day when launches will be scheduled vs number of launches.

2.2.2.2.9. Trajectory data:

2.2.2.2.9.1. Initial flight azimuth for single azimuth launches or desired azimuth sector for variable azimuth launches.

2.2.2.2.9.2. X, Y, Z, $\dot{X}$, $\dot{Y}$, $\dot{Z}$, as functions of time throughout powered flight. If position and velocity components cannot be provided, with the approval of WSMC/SE range and altitude values may be substituted for X, Y, Z, and the total earth-fixed velocity relative to the pad may be substituted for $\dot{X}$, $\dot{Y}$, $\dot{Z}$. The data should be provided in time intervals of less than five seconds.

2.2.2.2.9.3. Geodetic coordinates of launch site or location.

2.2.2.2.9.4. Map showing the planned locus of vacuum instantaneous impact points for the intended flight azimuth or azimuth sector. This map should show three sigma, drag-corrected impact dispersion areas for all stages, reentry vehicles, and jettisoned bodies.

2.2.2.2.9.5. Ballistic coefficient or drag data of all nominally jettisoned hardware, time of jettison, and free fall trajectory for all major spent stages.

2.2.2.2.9.6. Range from the launch pad to the vacuum impact point at times of discrete events; such as arming of engine cutoff circuits, ignition of upper stages, firing of retrorockets, and the end of burns that occur prior to orbital injection. The trajectory must be shaped for vehicles within the plus or minus three sigma limits so these events occur while the impact dispersion area is over water.

2.2.2.2.10. Supporting data and justification. The Range user may be asked to provide the following additional supporting data and justification before a decision on FPA can be made. NOTE: The need for this information is established in the WSMC/SE response to each FPA request or in the initial FPA discussions.

2.2.2.2.10.1. A statement of test objectives for powered flight.

2.2.2.2.10.2. Effect on the program (cost, schedule, data requirements, reliability) if the plan is not approved.

2.2.2.2.10.3. Statement of the test objectives that will not be met if the plan is not approved as proposed.

2.2.2.2.10.4. Any alternate flight plans that will accomplish the program objectives.

2.2.2.2.10.5. The effect on the program of modifying the proposed trajectory.

2.2.2.2.10.6. Any other data the Range user may wish to submit.

2.2.2.2.11. Buoyancy analysis. The Range user performs a buoyancy analysis of all impacting hardware. If the hardware will float, a means of sinking or aids to recovering floating items must be provided. If recovery is desired, a recovery procedure must be provided.

2.2.3. An Operation Approval Letter (OAL) is issued by WSMC/SE for each mission. It is the final statement indicating that safety preparation to support an operation is completed (based on the final submission of the flight safety data package as outlined in this regulation), airborne flight safety hardware is installed and checked out, and flight safety is ready to support.

2.2.4. Because of the importance of safety, a flight plan is not approved simply as a matter of convenience to the Range user if safer reasonable alternatives exist; nor is a destruct system waiver granted just to save the cost of receivers or other equipment. Flight plan approval is given or a waiver request granted when, in the Commander's judgment, the hazards associated with the proposed test appear reasonable and when the test objectives cannot be met in a safer fashion. A probability study serves as one basis for deciding whether the hazards are reasonable. If it is not apparent to WSMC Flight Safety Analysis Branch (SEY) that hazards involved are of an acceptable level, the Range user may be required to conduct a probability study or provide information (2.2.5 below) so that WSMC/SEY can make the study to evaluate hazards associated with launching a new flight plan. The requirements for a probability study are levied, if deemed appropriate by WSMC/SEY, during the initial contact with the Range user. A probability study is required if the flight plan involves any of the following:

2.2.4.1. Direct overflight (instantaneous impact position or present position) of land prior to thrust termination or orbital injection.

2.2.4.2. Flight so close to land that destruct criteria is violated by a normal vehicle.

2.2.4.3. Launch phase trajectory so steep that critical coastal areas cannot be protected by standard safety destruct criteria.

2.2.4.4. A period during flight when land areas cannot be protected from a malfunctioning vehicle because either the vehicle has no emergency flight termination system or the WSMC flight safety system capability is surpassed by the vehicle's performance.

2.2.5. The Range user may be required to supply the following reliability and malfunction analysis data. NOTE: The need for this information is established in the initial FPA discussions or in the WSMC/SE response to the FPA request.

2.2.5.1. Reliability of each stage.

2.2.5.2. Description of each failure or malfunction mode. An analysis of all subsystems should be made to determine those failure modes that would result in impact other than nominal.

2.2.5.3. A table defining flight time seconds (sec) versus malfunction turn probability density (per sec) and premature thrust termination probability density (per sec). A malfunction turn failure results when a failed vehicle is acted upon by a component of force perpendicular to its direction of flight that tends to result in displacement of the vehicle away from its planned line of flight. Thrust vector control loss and nozzle burn-through represent typical malfunction turn failures. A thrust termination failure results when a failed vehicle does not undergo any side forces. The latter type of failure can include engine shutdown, engine reduced thrust, vehicle explosion while on a nominal flight path, failure to initiate a programmed turn, and engine ignition failure, etc.

2.2.5.4. Description of pieces that would survive to impact, including:

2.2.5.4.1. Their impact dispersions.

2.2.5.4.2. Impact times.

2.2.5.4.3. Velocity imparted to each of these pieces by destruct action.

2.2.5.4.4. Evaluation of drag characteristics of each piece.

2.2.5.5. Nominal trajectory data, three sigma lateral trajectory data, turning rates, and drag data as described in paragraph 2.4.

2.3. Lead Times. Lead times for requesting SPA and FPA are discussed in paragraph 2.2. After FPA is granted, the Range user must provide detailed trajectory and vehicle performance data to WSMC/SEY in the specified format according to lead times established in table 2-1. Depending on the type of mission or test time, the requirements to be met are set forth in paragraphs 2.4, 2.5, 2.6, 2.7, 2.8, or 2.9.

Vehicle or Missile	Type	Lead Time
Ballistic Missile	Single Flight Azimuth, Multiple Trajectory or Flight Azimuth	60 days
Space Vehicle	Single Flight Azimuth or Variable Flight Azimuth	60 days
Ballistic/Space Vehicles	Programs with Flight Plan Approval (FPA)	30 days
	A single Program with FPA covering missions within a defined envelope or an identical mission	15 days*
Cruise Missile	Ground or Air Launched	30 days
Small Rocket	Without Destruct System	30 days
Inert Body	Air Dropped	30 days
Aircraft or Ship Sensor Support	Miscellaneous	30 days
Aircraft & Aeronautical Systems	Miscellaneous	30 days

*No new trajectory is submitted. Requires a special authorization accompanied by specific Program needs for this short lead time.

Table 2-1. Lead Times.

2.3.1. If deadlines are not met, WSMC/SEY may not be able to prepare all necessary safety criteria in time to support a proposed flight test. In this event, the test or mission will not be conducted until adequate safety preparations can be made.

2.3.2. In meeting the requirements of this chapter, much of the information submitted by the Range user may not change from vehicle to vehicle. In such cases, the information only needs to be supplied once. However, for each flight test, the Range user must state in writing which trajectory tapes or printouts are applicable, and specify the document, paragraph, and page number where each required item can be found. This statement must be submitted to WSMC/SEY according to the lead times established in table 2-1.

2.3.3. Although the requirements in this chapter are intended to be complete, special types of launches or special circumstances may make it necessary to request additional information from time to time. Such requests will be made in writing to the Range user.

2.3.4. In this chapter certain required data items are marked with an asterisk (*), for example, the time interval when turn angle graphs are required. The asterisk means that

the interval, duration, or magnitude for which the particular item is to be provided varies from program to program, and that the value listed is simply a typical value. For each vehicle program, WSMC/SEY states the particular value to use for each parameter marked with an asterisk.

2.3.5. The X, Y, Z coordinates referred to in this chapter must be referenced to an orthogonal, earth-fixed, left-handed system with origin at the launch point. The X, Y plane should be tangent to the ellipsoidal earth at the origin, the positive X axis should coincide with the initial flight azimuth, the positive Z axis should be directed away from the earth, and the Y axis should be positive to the right looking downrange.

2.3.6. The Range user must provide a security classification level cross correlation matrix table for trajectory information submitted to WSMC/SEY. This matrix table must indicate word classification levels for each word in the Binary Computer Decimal (BCD) and binary data files when associated with other words in the files in addition to the classification level of each singular word. If classification changes with stages or other events, a classification matrix must be included for each change.

2.4. Ballistic Missile and Space Vehicle Data Requirements. The trajectory and performance data requirements in this paragraph apply to all ballistic missiles and space vehicles. Lead time requirements are listed in table 2-1.

2.4.1. The following items are required for each missile flight or group of similar flights and should be updated as changes of vehicle configuration occur or revised information becomes available.

2.4.1.1. General information concerning the nature and purpose of the flight.

2.4.1.2. A scaled diagram of the general arrangement and dimensions of the missile or space vehicle.

2.4.1.3. Maximum turning capability of the total velocity vector vs time of flight, 2.4.4.1 below.

2.4.1.4. Effects of destruct action on each vehicle stage and drag data for resulting pieces, 2.4.4.2 below.

2.4.1.5. Brief, general discussion of typical failures which may occur during flight, 2.4.4.3 below.

2.4.1.6. Tracking aids (for example, C-Band beacon) installed in the vehicle that can be used for missile flight safety purposes and the location in the stage or section.

2.4.1.7. Expected impact point or aiming point for each stage of jettisoned body and associated drag data, 2.4.4.4 below.

2.4.1.8. Impact dispersion data for each stage and jettisoned body, 2.4.4.5 below.

2.4.1.9. Trajectory deviations (or any other conditions) beyond which the launch agency is no longer interested in the missile flight, and is willing to accept premature flight termination even though the missile may not have reached a dangerous position or altitude.

2.4.1.10. Reentry vehicle description and drag data, 2.4.4.6 below.

2.4.1.11. Time schedule of events such as ignition, cutoff and separation of each stage, firing of separation rockets, jettisoning of heat shields and nose fairings, initiation and termination of various control and guidance modes, coast periods, arming of engine cutoff circuits, and timer settings for backup engine cutoff signals.

2.4.1.12. Maximum possible impact range of each impacting stage or reentry vehicle for a missile burning to fuel exhaustion, 2.4.5.6 below.

2.4.1.13. For variable azimuth launches a complete set of firing tables giving launch time, date, initial and effective flight azimuths and profiles.

2.4.1.14. Land overflight data, 2.4.4.7 below.

2.4.1.15. Range safety telemetry and TMIG requirements (certain detailed information contained in chapter 4).

2.4.1.15.1. TMIG data is a mandatory requirement as a tracking source for programs using a launch vehicle inertial guidance system. The TMIG data is to be made available in the standard Inter-Range Instrumentation Group (IRIG) format at a 20 pulses per second (pps) rate.

2.4.1.15.1.2. Identification of available malfunction detection indicators with data word definition. These indicators are used by the Missile Flight Control Officer (MFCO) in verifying the validity of the TMIG data and as a check on the health of the guidance system.

2.4.1.15.1.3. The TMIG data is required at an accuracy that provides an Instantaneous Impact Point (IIP) uncertainty no greater than one nautical mile (nm) crossrange and no greater than three nm in the downrange direction.

2.4.1.15.1.4. The TMIG data is required during all phases of powered flight.

2.4.1.15.2. Missile and Flight Termination System data (PCM) shall be made available in a format acceptable to the Range at a 20 pps rate. Typical analog and digital telemetry data used for flight safety are:

2.4.1.15.2.1. Attitude data.

2.4.1.15.2.1.1. Yaw, pitch, and roll.

2.4.1.15.2.1.2. Yaw, pitch and roll rates.

2.4.1.15.2.2. Guidance status and performance data.

2.4.1.15.2.2.1. Gyro pick-offs or Specific Force Integrating Receiver (SFIR) data.

2.4.1.15.2.2.2. Error voltage.

2.4.1.15.2.2.3. Staging events.

2.4.1.15.2.2.4. RV release events.

2.4.1.15.2.2.5. X-Axis equivalents.

2.4.1.15.2.3. Airborne instrumentation status.

2.4.1.15.2.3.1. Battery voltages and current data.

2.4.1.15.2.3.1.1. Command receivers.

2.4.1.15.2.3.1.2. Transponder.

2.4.1.15.2.3.1.3. Guidance and control.

2.4.1.15.2.3.1.4. Telemetry.

2.4.1.15.2.3.1.5. Nozzle control units and thrust vector systems.

2.4.1.15.2.3.1.6. Premature Separation System (PSS).

2.4.1.15.2.3.1.7. Destruct ordnance power sources.

2.4.1.15.2.3.2. Instrumentation performance data.

2.4.1.15.2.3.2.1. Command receivers received signal strength.

2.4.1.15.2.3.2.2. Decoder function outputs.

2.4.1.15.2.3.2.3. Destruct events.

2.4.1.15.2.3.2.4. Transponder received signal strength.

2.4.1.15.2.3.2.5. Transponder Received Pulse Rate Frequency (PRF).

2.4.1.15.2.3.2.6. Transponder power output.

2.4.1.15.2.3.2.7. Telemetry transmitter power output.

2.4.1.15.2.3.2.8. Safe and Arm Device (S&A) position status.

2.4.1.15.2.3.2.9. PSS inhibit status.

2.4.1.15.2.3.2.10. Command function verification.

2.4.1.15.2.3.3. Propulsion system data.

2.4.1.15.2.3.3.1. Thrust chamber pressure for all stages.

2.4.1.15.2.3.3.2. Phase zero activation.

2.4.1.15.2.3.3.3. Fuel pressure.

2.4.1.15.2.3.3.4. Nozzle extension.

2.4.1.15.2.3.3.5. Nozzle position.

2.4.1.15.2.3.3.6. Command destruct receivers Automatic Gain Control (AGC).

2.4.1.15.2.3.3.7. X, Y, Z, Pendulous Integrating Gyroscope Accelerometer (PIGA) Resolvers.

2.4.1.15.2.3.3.8. Final stage disposal discrete.

2.4.1.15.2.3.3.9. General Energy Management System (GEMS) or other maneuvers or discretes.

2.4.1.15.2.3.3.10. Maneuvers or discrete initiation.

2.4.1.15.3. Real-time Digital Telemetry (TM) data.

2.4.1.15.3.1. X, Y, Z position.

2.4.1.15.3.2. X, Y, Z velocity.

2.4.1.15.3.3. X, Y, Z minor cycle PIGA sums.

2.4.1.15.3.4. Major cycle PIGA sums.

2.4.1.15.3.5. Flight safety word.

2.4.1.15.3.6. Gyro wide angle indicator.

2.4.1.15.3.7. Inertial Measurement Unit (IMU) power.

2.4.1.15.3.8. Gyro speed control.

2.4.1.15.3.9. Stage indicator.

2.4.1.15.3.10. Minor cycle counter.

2.4.1.15.3.11. Major cycle sync word.

2.4.1.15.3.12. All other system counter or sync word.

2.4.1.16. Burning rate of any solid propellants (inches per sec) at ambient atmospheric pressure.

2.4.1.17. Percent propellant TNT equivalency for each stage.

2.4.1.18. Stage ignition and burntime, total weight of propellant, and propellant density.

2.4.1.19. Approximate time interval from receipt of a destruct signal at the command antenna until destruct charges explode.

2.4.1.20. Acoustic intensity contours that are above 85 dB at 10 dB intervals generated during launch of the vehicle. The predominant acoustical bands above 85 dB at a distance of .5, 1, 2, and 3 nm surrounding the launch pad.

2.4.1.21. Two types of user input data are required for the Supersonic Aircraft Boom Effects Routine (SABER), control information and Near Field Signature (NFS). Flight profile data will be obtained by WSMC/SE from the nominal trajectory data.

2.4.1.21.1. Control information required:

2.4.1.21.1.1. R - distance from vehicle where NFS is determined, in feet (ft).

2.4.1.21.1.2. LM - length of model of vehicle in feet.

2.4.1.21.1.3. LR - vehicle length in feet.

2.4.1.21.2. NFS data with exhaust plume.

2.4.1.21.2.1. (theta) - roll angle, in degrees.

2.4.1.21.2.2. M - mach number.

2.4.1.21.2.3. N - number of points in NFS.

2.4.1.21.2.4. X - vehicle station on model where pressure perturbation was measured in feet.

2.4.1.21.2.5. Delta pressure perturbation - pressure perturbation divided by ambient pressure.

2.4.2. The trajectory data requirments must be calculated using a six degree of freedom program. All trajectories, except the three sigma launch area trajectories, must be provided from launch up to a point in flight where effective thrust of the final stage has terminated or to thrust termination of that stage or burn that places the vehicle in orbit. The launch area trajectories are required from lift-off. The trajectories must be provided on magnetic tape under AFSCM 80-12. The magnetic tape, two copies of the printout of the tape, and a letter of transmittal are provided to WSMC/SEY according to the lead times established in table 2-1.

2.4.2.1. For single azimuth launches, the trajectory data items of 2.4.3 below are required for the trajectories specified in paragraphs 2.4.2.1.1 through 2.4.2.2.8 below. These trajectories are computed for a normally performing missile.

2.4.2.1.1. Nominal or reference trajectory, 2.4.5.1 below.

2.4.2.1.2. Three sigma maximum-performance trajectory, 2.4.5.2, 2.4.5.3, and 2.4.5.7 below.

2.4.2.1.3. Three sigma minimum-performance trajectory, 2.4.5.2, 2.4.5.3, and 2.4.5.7 below.

2.4.2.1.4. Three sigma lateral trajectory, 2.4.5.4 and 2.4.5.7 below.

2.4.2.1.5. Fuel exhaustion trajectory, 2.4.5.6 below.

2.4.2.1.6. Three sigma steepest launch area trajectory, 2.4.5.5 and 2.4.5.7 below.

2.4.2.2. For variable azimuth and profile flights, the trajectory data items of 2.4.3 below are required for the trajectories. These are to be computed for a normal performance missile, 2.4.2.2.1 through 2.4.2.2.8 below.

2.4.2.2.1. Extreme right-hand or steepest nominal trajectory, 2.4.5.1 below.

2.4.2.2.2. Extreme left-hand or shallowest nominal trajectory, 2.4.5.1 below.

2.4.2.2.3. Centrally located nominal trajectory, 2.4.5.1 below.

2.4.2.2.4. Three sigma maximum-performance trajectory for the centrally located flight azimuth, 2.4.5.2, 2.4.5.3, and 2.4.5.7 below.

2.4.2.2.5. Three sigma minimum-performance trajectory for the centrally located flight azimuth, 2.4.5.2, 2.4.5.3, and 2.4.5.7 below.

2.4.2.2.6. Three sigma lateral trajectory for the centrally located flight azimuth 2.4.5.4 and 2.4.5.7 below.

2.4.2.2.7. Fuel exhaustion trajectory, 2.4.5.6 below.

2.4.2.2.8. Three sigma steepest launch area trajectory, 2.4.5.5 and 2.4.5.7 below.

2.4.3. This paragraph lists the trajectory data items required by 2.4.2 above. These items must be provided according to the coordinate system, accuracy, and definitions specified in AFSCM 80-12. The coordinate system for the AFSCM 80-12 format is also defined in paragraph 2.3.5. All data is submitted either in English or metric units.

2.4.3.1. X, Y, Z (ft) vs time (sec).

2.4.3.2. $\dot{X}, \dot{Y}, \dot{Z}$ (ft per sec) vs time (sec).

2.4.3.3. Speed = $(\dot{X}^2 + \dot{Y}^2 + \dot{Z}^2)^{1/2}$ (ft per sec) vs time (sec).

2.4.3.4. Path angle of velocity vector relative to local horizontal degrees (deg) vs time (sec).

2.4.3.5. Altitude above earth's surface (ft) vs time (sec).

2.4.3.6. Total weight pounds (lbs) vs time (sec).

2.4.3.7. Ground range along surface of earth from the origin (pad) to a point directly beneath missile nm vs time (sec).

2.4.3.8. Thrust lbs vs time (sec).

2.4.3.9. Instantaneous impact point data, geodetic latitude, longitude, impact range nm, and flight time (sec) vs time (sec).

2.4.3.10. The name, coordinates, and mean sea level elevation of the coordinate system origin (launch pad).

2.4.3.11. Initial flight azimuth in degrees measured clockwise from true north.

2.4.3.12. Name of spheriod used in trajectory calculations.

2.4.4. Provide background information and details about the general vehicle data requirements set forth in 2.4.1 above.

2.4.4.1. Maximum turning capability angle information is required only for those stages that contain an emergency flight termination system, and needs to be computed for the nominal or reference trajectory only.

2.4.4.1.1. Turning information is needed in order to know, at any time during flight, the maximum angle through which the velocity of a malfunctioning vehicle can turn in various time intervals. This information is used to determine how fast a vehicle, or more exactly, a vehicle's impact point, can attempt to violate an impact limit line if a malfunction should occur. Various time intervals, or time delays, must be considered, since the delays built into the Range safety destruct calculations depend upon the accuracy, sensitivity, and type of presentation associated with a particular instrumentation system as well as vehicle characteristics.

2.4.4.1.2. In determining the turning capabilities of a vehicle, the Range user considers both trimmed turns and tumbling turns. Trimmed turn refers to a turn where the angle of attack is such that the aerodynamic moment is just balanced by the thrust moment. A maximum-rate trimmed turn is a turn made at, or near, the greatest angle of attack that can be maintained whether the vehicle is stable or unstable. Tumbling turn means the family of turns that result if the airframe rotates through approximately 180 degrees at various angular rates, each rate being brought about by a different constant deflection of the rocket engine. The procedure outlined in 2.4.4.1.2.1 and 2.4.4.1.2.2 below should be followed in determining whether trimmed turns, tumbling turns, or both should be provided.

2.4.4.1.2.1. For vehicles that are aerodynamically unstable at all angles of attack, the following will apply: If the Range user can show that the probability of flying a maximum-rate trimmed turn even for a period of only a few seconds is virtually zero,

tumbling turns should be computed rather than trimmed turns. If the Range user cannot so state, both trimmed turns and tumbling turns must be considered with the larger of the two, or both, being provided. In those cases or during that part of the flight where the maximum trimmable angle of attack is small, it may be obvious which type turn leads to greater turning angles; however, if the maximum trimmable angle of attack is large, trimmed turns will in all probability lead to higher turning angles than tumbling turns, and hence more restrictive destruct criteria. Therefore, tumbling turns should be submitted at any point where the Range user can state that there is no conceivable way for the vehicle to fly a maximum-rate trimmed turn. One possible difficulty needs to be mentioned in connection with calculating tumbling turns for unstable vehicles. In the higher aerodynamic region it often turns out that no matter how small the initial deflection of the rocket engine, the airframe tumbles through 180 degrees or one-half cycle in less than eight seconds, the minimum time duration for computing turning angles during the boost phase. In such a case, if the computation is carried out for eight seconds, part of the angle turned by the velocity vector during the first half cycle is then cancelled out during the second half cycle of the turn. If only tumbling turns were considered in such cases, the conclusion would be that the vehicle's velocity vector can turn through a greater angle in a shorter time period than it can in a longer time period. This is an unacceptable conclusion from a safety viewpoint. One generally acceptable way to circumvent this difficulty is to compute tumbling turn angles without considering aerodynamic forces. Although such a vacuum turn cannot actually be simulated in the atmosphere by means of a constant engine deflection, in all likelihood there is a particular deflection of the engine that can approximate the turn fairly closely. If, however, vacuum tumbling turns are considered completely unrealistic and unjustifiable, other types of malfunctions must be considered. If, for times greater than the maximum time required to tumble through 180 degrees, no likely type of malfunction can occur that leads to larger turning angles than those achieved for tumbling turns, then maximum-rate trimmed turning angles must be provided in addition to the tumbling turning angles.

2.4.4.1.2.2. For vehicles that are stable at all angles of attack, or unstable at low angles of attack but stable in some higher angle of attack region, the following shall apply: If the vehicle is so stable that the maximum thrust moment cannot produce tumbling but results instead in trim at some angle of attack less than 90 degrees, turning angles should be computed for this trim angle of attack. If the maximum thrust moment results in trim at some angle of attack greater than 90 degrees, turning angles should be computed for an angle of attack of 90 degrees. It is quite likely, however, that the maximum thrust moment will be capable of tumbling the vehicles. In this event, two possible situations arise: large engine deflections result in tumbling, but small engine deflections do not; both large and small constant engine deflections result in tumbling, irrespective of how small the deflection might be. For the first case, tumbling turn envelopes should be generated as prescribed in the 2.4.4.1.2.1 above for unstable vehicles. However, the same difficulty discussed there in connection with tumbling turns may arise here. The envelope of the computed tumbling turns may fail to rise continuously throughout the entire time period when the calculations are to be carried out. In this event, either tumbling turn calculations neglecting aerodynamic forces or maximum-rate trimmed turn calculations must be made as discussed in the preceding paragraph. In the latter case, this situation arises because the stability at high angles of attack is insufficient to arrest the angular velocity that is built up during the initial part of a tumbling turn where the vehicle is unstable. For this case, the turning angles achieved at the stability angle of attack (assuming no upsetting thrust moment) are required in addition to the turning angles achieved by a tumbling vehicle. Although the vehicles cannot arrive at this stability angle of attack as a result of a constant engine deflection, there is certainly some deflection behavior that will produce this result. If arriving at such a deflection program is too difficult or too time consuming, it is assumed that the vehicle somehow instantaneously rotates to the trim angle of attack and stabilizes at this point. In connection with

the latter case, the Range user may feel that the probability of achieving a trimmed turn is extremely small; if so, tumbling turn angles may be used in range safety destruct calculations during that part of flight that the envelope rises continuously for the duration of the computation.

2.4.4.1.3. Irrespective of the type of turn computed, turning angle graphs are required at even 4* second intervals beginning 4* seconds after first motion and continuing through the stage I phase and into the stage II phase for at least one time point, and at even 8* second intervals thereafter. One graph is to be provided for each computation time, with each ordinate representing the total angle turned by the velocity vector in degrees and each abscissa the time duration of the turn in seconds. For other than tumbling turns, only a single graph is required at each time point. For tumbling turns each graph is to represent the envelope of all tumbling turns for all possible constant deflections of the rocket engine. In this case, a plot of the individual tumbling turn curves that are used to define the envelope must be provided on the same graph with the envelope. Additional data required on each graph of turning rates are the thrust, weight, and velocity at the beginning of each turn. The time duration of each turn is to be at least 12* seconds during the stage I phase, and at least 16* seconds for all turns computed thereafter. During the first 100* seconds of flight, both pitch turns and lateral turns must be investigated and the larger of the two be presented. However, after 100* seconds, turns need be computed only in the lateral plane. Lateral turn in this case means the angle turned in the lateral direction by the total velocity vector, not the angle turned in the horizontal plane by the horizontal component. If pitch and lateral turning angles are essentially the same except for the effects of gravity, the lateral turning angles may be determined from the pitch calculations that, in effect, have had the gravity component subtracted out at each step in the computation. In all such cases and for all pitch turn calculations, the effects of gravity should be removed from the final turning angle plots.

2.4.4.1.4. In addition to the angle turned by the velocity vector, values of velocity are also required throughout each turning angle computation. For trimmed turns where only a single turning angle curve and a single set of velocity values exist for each calculation, velocities are required at one second intervals. For tumbling turns, velocities must be provided in graphical form as a function of time for each engine deflection used to define the tumble turn envelope. Either total velocity or incremental change in velocity from time of malfunction can be presented, although the incremental change in the velocity is desired.

2.4.4.1.5. In beginning the various turning angle computations, it should be assumed that the vehicle has behaved normally up to the point of the malfunction that produces the turn. Computations need not be made for the three sigma maximum and the three sigma minimum trajectories, but a method for applying the turning angles to these trajectories must be provided. The items of 2.4.3 above must also be supplied for the trajectories used to start the turning angle computations, if this trajectory is not one of those provided in response to 2.4.2.1 above. Although desirable, this trajectory need not be submitted on tape in the standardized format of AFSCM 80-12. A columnar or block printout is acceptable for this trajectory. In addition, a complete discussion is required of assumptions made, method of calculations, and equations used in deriving the turning angles. A statement relative to the probability of occurrence of the various type turns considered is required.

2.4.4.2. To meet the requirements of 2.4.1.4 above, the following must be provided up to thrust termination of the last stage that carries a destruct system:

2.4.4.2.1. The expected effects of destruct action on the vehicle structure, including estimates of the number and approximate weights and cross-sectional areas of pieces. All fragments must be included; however, similar fragments such as skin or structural vehicle weight should be accounted for in the fragment groups. The description should

also include diffusion and dispersion of any toxic or radioactive clouds or fragments and the radiation and exposure characteristics. This information is necessary to develop safety criteria and perform launch area hazard analysis.

2.4.4.2.2. Estimates of the coefficient of drag (C_D) versus Mach number specifying reference area (A), approximate weight (W), shape and volume should be given for each piece or group of pieces resulting from destruct action. For each group of similar fragments the number of pieces, weight variation of pieces, total weight, and variation in cross-sectional area of the pieces must be specified. A piece that in the absence of wind is expected to travel a maximum distance, and a piece (or pieces) that in the absence of wind is expected to travel a minimum distance must be included. All C_D versus Mach number curves must be provided in graph form. Include equations for these curves if available.

2.4.4.2.3. The difficulty in estimating drag coefficient curves and weights for vehicle pieces is fully realized. If this cannot be done satisfactorily, an estimate of the subsonic and supersonic W/C_DA for each major piece may be provided instead. In either form, three sigma tolerance limits for the drag coefficients given for the maximum and minimum distance piece must be included.

2.4.4.2.4. For pieces that may stabilize during free flight, drag coefficient curves should be provided for this angle of attack. If the angle of attack where the piece stabilizes is other than zero degrees, both the coefficient of lift (C_L) versus Mach number and the C_D versus Mach number curve should be provided.

2.4.4.2.5. The explosion effect on the remaining fuel and stages are also required, particularly with respect to ignition or detonation of upper stages if destruct action is taken during the burning period of a previous stage. If one of the upper stages can be ignited as a result of destruct action taken on a previous stage, sufficient information is required to evaluate the effects and duration of thrust, and the maximum deviation that can be brought about by this thrust.

2.4.4.2.6. Estimate of incremental velocities imparted to the vehicles pieces.

2.4.4.2.6.1. Vehicle break-up mode data:

2.4.4.2.6.1.1. A statement indicating the flight time interval when the vehicle is experiencing the "high q" flight region. This region is defined as the time during flight when the dynamic pressure causes an aerodynamic breakup during a malfunction time with the result of little or no crossrange displacement.

2.4.4.2.6.1.2. For each vehicle stage flight interval, provide fragmentation group information resulting from the expected effects of destruct action on the vehicle structure. Also, provide information resulting from the "high q" load considerations (aerodynamic break-up) as defined in 2.4.4.2.6.1.1 above, as well as for an intact vehicle. A fragment "group" is one or more fragments whose characteristics are similar enough to allow all of the fragments to be described by a single "average" set of characteristics. The following information is required for each fragment group:

2.4.4.2.6.1.2.1. Fragment group name.

2.4.4.2.6.1.2.2. Nominal, plus three sigma and minus three sigma ballistic coefficient values (lbs per square ft).

2.4.4.2.6.1.2.3. Weight per fragment (lbs).

2.4.4.2.6.1.2.4. Projected area per fragment (ft^2). This information is not required for those fragment groups classed as uncontained propellant fragments, 2.4.4.2.6.1.2.6 below.

2.4.4.2.6.1.2.5. Plus three sigma destruct induced velocity (ft per sec).

2.4.4.2.6.1.2.6. Fragment group type, note 1 below, where:

1 = inert fragment.
2 = uncontained propellant fragment.
3 = contained propellant fragment.
4 = explosive fragment.

2.4.4.2.6.1.2.7. Casualty area per fragment (ft^2). The casualty area per fragment should be based on a fragment falling vertically at impact.

2.4.4.2.6.1.2.8. Vehicle stage where fragment group originated.

2.4.4.2.6.1.2.9. For those fragment groups defined as uncontained propellant fragments, contained propellant fragments, and explosive fragments, an indication is required as to whether or not the propellant fragments are burning during free fall.

2.4.4.2.6.1.2.10. For those fragment groups defined as contained propellant fragments or explosive fragments, the initial weight of contained propellant (lbs), note 2 below, and the consumption rate during free fall (lbs per sec) is required.

2.4.4.2.6.1.2.11. Fragment terminal velocity (ft per sec).

NOTE 1. Inert fragments contain no volatile type material that could be burning or could explode. Uncontained propellant is propellant exposed directly to the atmosphere (it is assumed that exposed propellant will not produce a significant explosion upon impact). Contained propellant is propellant that is enclosed in a container (such as a motor case) but will not explode upon impact. Explosive fragments are contained propellant fragments that will explode upon impact.

NOTE 2. The initial weight of a contained propellant fragment is the weight of the propellant in a fragment before any of the propellant is consumed by normal vehicle operation. This propellant weight must be less than the total weight per fragment.

2.4.4.2.6.2. Destruct Velocity Impact Uncertainties. This data is required for those fragments identified in 2.4.4.2.6 above, with a plus three sigma destruct induced velocity of greater than 500 ft per sec. This information provides a more realistic impact uncertainty due to high velocity destruct fragment modeling. The data required can be best shown in terms of a table indicating:

2.4.4.2.6.2.1. Flight time when the destruct velocity impact uncertainties are to be used (sec).

2.4.4.2.6.2.2. Ballistic coefficients band upper bound values (lbs per ft^2).

2.4.4.2.6.2.3. For each ballistic coefficient band upper bound value at each flight time specified above, the destruct velocity impact covariance matrix elements (nm^2). These elements consist of a downrange variance, crossrange variance, and a downrange or crossrange covariance. The upper bound ballistic coefficient values define range of ballistic coefficients for which the impact uncertainties have been computed (that is, from a Monte Carlo analysis). The lower bound for each band can be most easily handled if it is assumed to be equal to the upper bound for the previous band with the lower bound for the first band being zero.

2.4.4.3. For typical failures, 2.4.1.5 above, for each stage, a brief discussion about:

2.4.4.3.1. Typical malfunctions that may occur, such as failure of the hydraulic system, failure of the guidance or control system, failures that lead to premature thrust termination (such as shifting of platform reference, structural failures, failure of separation mechanism between stages).

2.4.4.3.2. Expected or possible vehicle behavior for these failures.

2.4.4.3.3. An estimate of the probability of their occurrence. Also state any other information considered pertinent with respect to critical portions of flight, vehicle stability characteristics, and structural limits.

2.4.4.4. The expected impact points, 2.4.1.7 above, for each stage and jettisoned body should be given in terms of geodetic latitude and longitude in decimal degrees, and range (nm) from pad to impact point. Computations should be made for an ellipsoidal rotating earth taking into account drag and, if applicable, lift.

2.4.4.4.1. Scheduled debris data required for each scheduled jettison item (stages, panels, shroud, etc.):

2.4.4.4.1.1. The number of fragments resulting from a specific scheduled jettison.

2.4.4.4.1.2. Jettison flight time (sec), total weight jettisoned (lbs), reference area per fragment (squared ft), and the best estimate of C_D vs Mach number or subsonic and supersonic W/C_DA for each stage or piece.

2.4.4.4.1.3. Three sigma major axis (nm) and three sigma minor axis (nm) impact distribution uncertainty and the azimuth orientation of the major axis (degrees clockwise from true north).

2.4.4.4.1.4. Impact ballistic coefficient (lbs per ft^2).

2.4.4.4.1.5. A table of Mach number vs the nominal, minus three sigma and plus three sigma drag coefficients and respective reference areas. The Mach numbers for which drag coefficients are input must cover the range of possible Mach numbers that could be encountered for the scheduled fragment(s) during free fall.

2.4.4.5. The impact dispersion data requested in 2.4.1.8 above are required for warning notices for civilian aircraft, and in determining what areas, if any, must be clear of shipping not associated with the test. Estimates of the three sigma range and crossrange dispersions are required for each stage or jettisoned body, assuming a normally functioning vehicle. Three sigma wind effects acting, upon the descending body or pieces, must be included in the dispersion area. If more than one vehicle piece impacts in the vicinity of a particular point, or if any stage is expected to break up during reentry, an estimate of the number and size of pieces, their impact range, or the extreme range limits for these pieces must also be provided. A brief discussion of the method used to determine dispersion should also be provided.

2.4.4.6. The following information for reentry vehicle description drag data and for weapons systems or reentry vehicle development tests is required. The items in 2.4.4.6.1 through 2.4.4.6.4 below should be provided in records 23, 24, and 25 of the SCD file of the AFSCM 80-12 trajectory tape or submitted with general vehicle data.

2.4.4.6.1. Type of reentry vehicle (ablation or heat sink) and ablation tables when applicable. The ablation table should consist of a table of Mach number or altitude vs the ratio (W/W_0) and the instantaneous reentry vehicle weight during reentry to the unablated reentry vehicle weight.

2.4.5.1. The nominal or reference trajectory is the trajectory that the vehicle would fly if all vehicle parameters were exactly as expected, if all vehicle systems performed exactly as planned, and there were no external perturbing influences.

2.4.5.2. To generate a single composite three sigma trajectory, use the following procedure:

2.4.5.2.1. Identify individual parameters (for example, thrust, weight, specific impulse, etc.) which significantly affect the IIP performance of the vehicle. Estimate three sigma dispersions for these parameters.

2.4.5.2.2. Run a series of trajectory computations, or simulations, where three sigma values of significant perturbing parameters are introduced singly. At a suitable number of points, tabulate the IIP deviations from nominal that have been caused by each parameter.

2.4.5.2.3. At each point, calculate the square root of the sum of the squares of all deviations to arrive at the three sigma IIP deviations.

2.4.5.2.4. By further trajectory computations or simulations, generate a powered flight trajectory (a three sigma no-wind trajectory) that matches as closely as possible the three sigma deviations calculated in 2.4.5.2.3 above. This may be done by perturbing only a few key parameters at varying magnitudes throughout the run.

2.4.5.2.5. Compute the required three sigma trajectory using "worst winds" and the parameter magnitudes used to calculate the three sigma no-wind trajectory. The wind dispersed trajectories indicate vehicle performance deviations due to the effects of severe winds. This data should be supplied until the missile attains an altitude where there is essentially no wind effect. It is usually sufficient to use 100,000 feet as this altitude limit. Computations should not be limited to wind drift but includes all wind effects. The suggested wind profile data for use in these computations are contained in the Inter-Range Instrumentation Group, Range Commanders Council, Document 104-63, August 1965, Pacific Missile Range Reference Atmosphere for Point Arguello, California (part 1). U.S. Government agencies may obtain this report from:

Secretariat
Range Commanders Council
White Sands Missile Range NM 88002

United States aerospace industries may obtain this report from:

DDC/IRA
Cameron Station
Alexandria VA 22314

2.4.5.3. The three sigma maximum- and three sigma minimum-performance trajectories define, at any time after launch, the limits of normality as far as impact range is concerned. The three sigma maximum-performance trajectory provides the minimum downrange distance of the vacuum IIP for any given point in time and the three sigma minimum-performance trajectory provides the minimum downrange distance of the IIP for any time. In calculating these trajectories, head and tail wind profiles should be used that represent the worst wind conditions when a launch would be attempted. For any particular time after launch, approximately 99.73 percent of all normal vehicles (assuming a normal distribution) that are subjected to the assumed wind will have impact ranges lying between the extremes achieved at that time by three sigma maximum-performance and three sigma minimum-performance missiles. Of the .27 percent of the normal vehicles that fall outside of the three sigma limits, approximately half would be short and half would be long. It is recognized that it may not be possible for a

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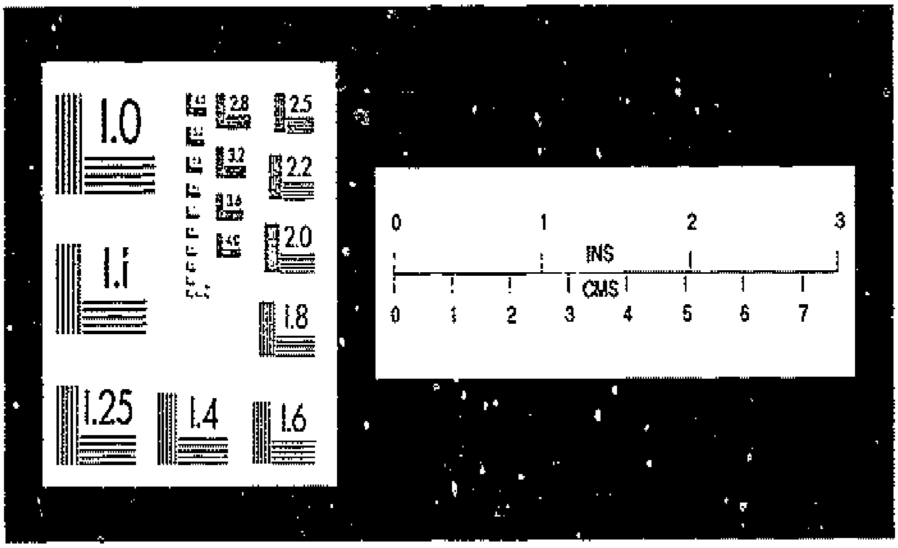

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2.4.4.6.2. The unablated reentry vehicle weight.

2.4.4.6.3. A table of reentry vehicle drag coefficient versus Mach number of altitude.

2.4.4.6.4. Reentry vehicle aerodynamic reference area associated with the drag coefficients.

2.4.4.6.5. A description of the effects of explosive warheads, if applicable. This description includes, but is not limited to, the:

2.4.4.6.5.1. Location and altitude of the point where the device is intended to be detonated.

2.4.4.6.5.2. Effects of detonation on the vehicle and reentry vehicle containing the device.

2.4.4.6.5.3. Dispersion of the resulting fragments. The description should also include diffusion and dispersion of any toxic or radioactive clouds or fragments and the radiation exposure characteristics.

2.4.4.7. For land overflight data, the following information is used to establish guidelines for safety action decisions. The ultimate use of this information depends on land overflight hazards and mission objectives. The requirement for this information is not mandatory; however, with this information more latitude can be exercised in establishing limits for land overflight. The derivation of the following items may be lengthy. Therefore, when necessary, WSMC/SE will accept information based on the Range user's best estimate.

2.4.4.7.1. The flight azimuth limits where the primary test objectives and a useful orbit can be accomplished. These azimuth limits are used to establish bounds for safety action decisions. For both, a complete explanation is required of:

2.4.4.7.1.1. The powered flight objectives that are met by the azimuth selections.

2.4.4.7.1.2. The circumstances or type of malfunction that can cause the vehicle to fly outside the three sigma limits of normality but still accomplish use objectives.

2.4.4.7.1.3. The probability of such a malfunction occurring.

2.4.4.7.1.4. An explanation of the effect of this malfunction on the success of succeeding burns or stages.

2.4.4.7.2. The most lofted and depressed trajectories where the primary test objectives and a useful orbit can be accomplished. These trajectories should consider only perturbations that result in deviations in the pitch plane. Position and velocity data in the AFSCM 80-12 format are required for these trajectories and the information requested in 2.4.4.7.1.1 thru 2.4.4.7.1.4 above, is also required.

2.4.4.7.3. The minimum (and maximum if it exists) impact range from the pad as a function of time when an orbit can be accomplished. These ranges should be such that orbit cannot be accomplished if the impact range, as a function of time, is less or greater than the limits specified for orbit. This information should be supplied at staging times and at sufficient other times to confirm the orbit capability.

2.4.5. Trajectory data details and background information about the trajectory data requirements are set forth in 2.4.2 above. A brief discussion of the parameters considered, their standard deviations, and all assumptions and procedures used in deriving each of them must be provided. A graph and tabulation of the wind profiles used must also be included.

normally performing, fully guided vehicle to fly either the three sigma maximum- or minimum-performance trajectory as defined above. However, what is wanted is a single trajectory having an impact range at any time greater than the impact range of 99.86 percent of all normal vehicles, and a single trajectory with an impact range at any time less than the impact range of 99.86 percent of all normal vehicles. Any deviation outside of three sigma limits indicates the vehicle is probably behaving in an abnormal, though not necessarily dangerous, fashion. Those parameters having a significant effect upon impact range, such as thrust, specific impulse, weight, variation in firing time of different stages, and fuel flow rate should be combined in the best way considered to produce the required results.

2.4.5.4. Three sigma lateral trajectory requirements:

2.4.5.4.1. The three sigma lateral trajectory defines the lateral limits of normality for the vacuum IIP. This trajectory is calculated using the worst lateral wind condition when a launch would be attempted. For any downrange distance, the IIP trace for 99.73 percent of all normal vehicles subjected to the assumed wind will lie between the nominal and the three sigma lateral IIP traces. Since only one, three sigma lateral trajectory is requested for single azimuth launches, the assumption is made that the three sigma left and the three sigma right trajectories are symmetric about the nominal trajectory. If this assumption is not reasonable, then both three sigma left and three sigma right trajectories must be provided. For multiple azimuth launches a similar assumption is made with respect to symmetry of the three sigma trajectories about each nominal trajectory. However, the further assumption is made that the three sigma lateral trajectory computed for the centrally located azimuth can be used to produce a three sigma trajectory for any other nominal azimuth simply by reorienting the X and Y axes of the data. For example, if a three sigma lateral trajectory has been computed for a nominal 200 degree flight azimuth, the three sigma lateral trajectory for a nominal 190 degree flight azimuth is determined simply by assuming that the X-axis of the trajectory is 190 degrees instead of 200 degrees. If this assumption is not reasonable, additional trajectories can be defined for any flight azimuth.

2.4.5.4.2. The three sigma lateral trajectories are needed to determine whether a normal vehicle experiencing a three sigma deviation violates flight safety destruct criteria. In other instances, they may be used as the primary criteria for deciding whether a vehicle should be allowed to continue in flight or to overfly land. When used for comparison with impact predictor destruct criteria, the vacuum IIP data are required. However, X, Y, and Z values along the three sigma lateral trajectory are also used for comparison with present-position destruct criteria. The three sigma lateral trajectory, as defined above in terms of IIP, may not provide three sigma deviations of the lateral position Y as a function of X, although this is normally assumed to be the case. The Range user should indicate if this assumption is not valid. Although not required, it would be useful in this case if the Range user would also submit a three sigma lateral trajectory which provides three sigma values of Y in terms of X.

2.4.5.4.3. In calculating a three sigma lateral trajectory, those parameters having a significant effect on the lateral deviation of the IIP should be combined in the best way considered to produce the required results. The same procedure suggested in 2.4.5.3 above for calculating three sigma maximum- and minimum-performance trajectories is also suggested here.

2.4.5.5. As the name implies, the three sigma steepest launch area trajectory should maximize Z as a function of X. In calculating this trajectory, a wind profile should be assumed that represents the worst wind conditions when a launch would be attempted. If other factors such as gyro drift or high thrust add significantly to the deviations caused by wind, these factors should also be included in the calculations. The steepest trajectory is a three sigma trajectory in the sense that 99.73 percent of all normal vehicles subjected to the assumed wind would, for any X, achieve values of Z below the corresponding Zs along the steepest trajectory.

2.4.5.6. For many flights, a programmed thrust termination may be scheduled well in advance of fuel exhaustion. To know whether a potential safety problem can arise if the vehicle should fail to cut off, trajectory data through fuel exhaustion are needed. For weapons system flight, the information should be provided for the last stage only. For orbital flights, it should be provided for the stage preceding the stage that achieves orbit. The requirement is met by extending either the nominal or three sigma maximum trajectory through fuel exhaustion, depending on which produces a greater impact range. This trajectory, properly identified, must be presented on magnetic tape according to AFSCM 80-12.

2.4.5.7. If the three sigma trajectories are computed as specified and the proposed flight plan is approved by WSMC/SE, the Range user can be certain that a normal vehicle does not violate the safety destruct criteria in the launch area. It is usually advisable to select profiles from the annual profiles contained in the IRIG document unless the launch is to be conducted at a particular time of the year and only at that time. Care should be exercised in the selection of the cumulative percentage frequency of the wind profile used for the computation of these trajectories. Selecting a wind profile as severe as the worst wind conditions when a launch would be attempted is usually recommended. This has the advantage of relieving the Range user or the representative of the task of evaluating wind effects on launch day to make sure the vehicle will not violate established flight safety destruct criteria. In critical instances, this has the disadvantage of limiting the allowable launch azimuth or reducing the allowable launch day winds in the flight safety restrictions for wind drift of vehicle fragments resulting from destruct. The wind profiles used in the computations should be identified. If the IRIG wind profiles are not used, a tabulation of wind magnitude and direction vs altitude is required for the profile actually used. WSMC/SE, in the destruct criteria, allows for as much vehicle deviation due to wind as shown in these trajectories, but does not assume responsibility for the safety of a vehicle launched under wind conditions that exceed those used in these computations.

2.4.6. For air launched ballistic and space vehicles, the data requirements outlined in 2.4.1 thru 2.4.6 above and paragraph 2.9 apply in addition to:

2.4.6.1. Type of aircraft and performance capability of aircraft, that is, turn rate, climb rate, velocity, etc.

2.4.6.2. Description of drop aircraft flight plan, such as aircraft flight azimuth in degree true, speed, altitude, flight path angle (at missile drop point) of velocity vector relative to local horizontal at launch.

2.4.6.3 For other than level flight launches, add a statement on how the aircraft path angle and launch azimuth are determined for missile release.

2.4.6.4. The expected maximum region around the drop point, that is, a drop point envelope where the test is conducted. This is provided as distances downrange, uprange, and crossrange relative to the expected drop point and perpendicular to the launch azimuth or by providing the geodetic latitude and longitude of the corners of the drop box.

2.4.6.5. The rate of drop of launched missile and description of stabilizing system used.

2.4.6.6. Method of ignition and position of the missile relative to the earth at ignition.

2.4.6.7. A definition and description of events occurring prior to missile release and to time of engine ignition.

2.4.6.8. Description of guidance system used, how ignition time and altitude are determined.

2.4.6.9. Predicted impacts of jettison hardware and their dispersion associated with the missile drop system.

2.4.6.10. Predicted impact point of jettison hardware and missile, and the associated dispersions resulting from ignition failure. The dispersions should include wind effects to all impacting debris.

2.4.7. Statement of Vehicle Performance is required within one to three months after a failure occurs during a vehicle test. This information is provided by written letter or by lending WSMC/SE the performance evaluation documents prepared for other purposes. Information desired includes:

2.4.7.1. Qualitative statement about the performance of each stage and the various subsystems.

2.4.7.2. Failures that occurred and resulting flight conditions produced.

2.4.7.3. Probable cause of failure and corrective action taken.

2.4.7.4. Impact points for stages.

2.4.7.5. Miss distances for weapons systems tests.

2.4.7.6. Comparison for planned and achieved cutoff for each stage.

2.4.7.7. Performance of on-board safety instrumentation systems.

2.5. Cruise Missile Data Requirements. The trajectory and performance data requirements set forth under this heading apply to cruise missiles. Lead time requirements are listed in paragraph 2.3.

2.5.1. The following missile related items are required for each missile flight or group of similar flights.

2.5.1.1. General information concerning the nature and purpose of the flight.

2.5.1.2. A scaled diagram of the general arrangement and dimensions of the missile.

2.5.1.3. Location of tracking equipment on board the missile that is used for missile flight safety tracking, such as S or C band beacon, telemetry transmitter.

2.5.1.4. General discussion of the typical failures that may occur during flight (for example, loss of control, shutdown of engine), an estimate of the probability of occurrence for each type of failure, and expected missile behavior for these failures. Any other pertinent information with respect to missile stability characteristics, peculiarities, structural, and g-limits.

2.5.1.5. Maximum turning capability of velocity vector (deg or sec) vs time of flight (sec-min), 2.5.4.1 below.

2.5.1.6. A description of the effects of destruct action on the missile and drag data for resulting pieces, 2.5.4.2 below.

2.5.1.7. Expected impact point or aiming point for missile and each jettisoned body, and associated drag data.

2.5.1.8. Impact dispersion data for each stage and jettisoned body.

2.5.1.9. Maximum possible impact range for missile burning to fuel exhaustion.

2.5.1.10. Trajectory deviations (or any other conditions) beyond where the Range user is no longer interested in the vehicle flight and thus is willing to accept a premature flight termination even though the vehicle may not have reached a dangerous position or altitude.

2.5.1.11. Graphs of fuel weight (pounds) vs time (sec-min) and gross weight (pounds) vs time (sec-min).

2.5.1.12. Explosive warhead information, 2.5.4.3 below.

2.5.1.13. Graph of maximum cruising speed (ft or sec) vs altitude (ft).

2.5.2. For each cruise missile flight or group of similar flights, five separate and distinct trajectories must be defined as indicated below:

2.5.2.1. For nominal or expected trajectory, provide all data items in 2.5.3.1 through 2.5.3.5, and 2.5.5.1 below.

2.5.2.2. For three sigma maximum-altitude trajectory, provide either the data items in 2.5.3.1 below, or the maximum-altitude high deviations (in feet) from nominal as a function of ground range from the launch or drop point, 2.5.5.2 and 2.5.5.5 below.

2.5.2.3. For three sigma minimum-altitude trajectory, provide either the data items in 2.5.3.1 below, or the maximum-altitude low deviations (in feet) from nominal as a function of ground range from the launch or drop point, 2.5.5.2 and 2.5.5.5 below.

2.5.2.4. For three sigma lateral trajectory, provide either the data items in 2.5.3.1 below or the maximum lateral deviations (feet or miles) from the intended flight path as a function of ground range from the launch or drop point, 2.5.5.3 and 2.5.5.5 below.

2.5.2.5. For three sigma high-performance trajectory, provide all data items in 2.5.3.1 and 2.5.3.2 below from launch or drop until the vehicle reaches a steady state cruise condition, 2.5.5.4 and 2.5.5.5 below.

2.5.3. The following trajectory data items are required for each flight according to the requirements and definitions set forth in 2.5.2 above. The information must be provided in tabular form in one second intervals for the first two* minutes of flight, in 15 second intervals from this point until the missile reaches cruise altitude, in one minute intervals throughout the cruise phase until the terminal phase of flight is reached, and at 15 second intervals thereafter until test termination or impact. The time 0.0 seconds must correspond to first motion for pad launched vehicles and to the instant of drop for air launchings.

2.5.3.1. After the first two minutes of flight, with WSMC/SE approval, X, Y, Z, (to the nearest foot) vs time (sec) is replaced by ground range along earth's surface from launch point to submissile point (ft-miles) vs time (sec-min), altitude above the earth's surface (ft) vs time (sec-min), and crossrange displacement (ft-miles) vs time (sec-min).

2.5.3.2. After the first two minutes of flight, with WSMC/SE approval, X, Y, Z (to the nearest one-tenth foot per second) vs time (sec-min) is replaced by speed (ft or sec) vs time (sec-min) and path angle of velocity vector relative to local horizontal (deg) vs time (sec-min).

2.5.3.3. Geodetic latitude and longitude of launch pad or drop point.

2.5.3.4. Initial flight azimuth in degrees measured clockwise from true north.

2.5.3.5. A map showing the expected flight path over the surface of the earth, and an altitude profile correlated with the flight path. Times should be indicated at regular intervals along the path.

2.5.4. This paragraph provides background information and details about the general vehicle data requirements set forth in 2.5.1 above.

2.5.4.1. Maximum turning capability details are:

2.5.4.1.1. From launch or drop until cruise altitude is reached, this information is required to provide a means of determining the maximum angle that the missile velocity vector can turn in the event of missile malfunction. The maximum angles turned for time intervals up to about 30* seconds duration are of interest. Both pitch and lateral turns should be investigated and the larger presented. It should be assumed the missile has behaved normally up to the point of malfunction that produces the maximum rate turn, the missile is trimmed to the maximum air load the structure can stand, or the missile is flying out of control in an altitude that produces the maximum lateral acceleration (for example, a near 90 degree bank with a maximum pitch turn). During the launch phase, the missile may not be able to fly for 30* seconds under these extreme conditions. In this event, it is assumed the missile is turned at the maximum possible rate where flight can be maintained. A complete discussion of the methods used in calculating must be provided. This discussion includes all assumptions made, types of malfunctions considered, forces producing turns, and equations used.

2.5.4.1.2. During the cruising phase, the maximum turning rate of the velocity vector, as a function of altitude, is required. Rates are based on normal missile weight and expected cruising speed at each altitude. For this phase of flight, the data may be expressed in the form of maximum lateral accelerations, if desired. A complete discusssion similar to that requested for 2.5.4.1.1 above is required. The maximum turning rates that the guidance system and the autopilot can command during the cruise phase are also required.

2.5.4.2. For destruct action effects to meet the requirements of 2.5.1.4 above, the following must be provided up to thrust termination of the last stage that carries a destruct system.

2.5.4.2.1. The expected effects of destruct action on the vehicle structure, including estimates of the number and approximate weights and cross-sectional areas of pieces. All fragments must be included; however, similar fragments such as skin or structural material are grouped together. The total structural vehicle weight should be accounted for in the fragment groups. The description should also include diffusion and dispersion of any toxic or radioactive clouds or fragments and the radiation and exposure characteristics. This information is necessary to develop safety criteria and perform launch area hazard analysis.

2.5.4.2.2. Estimates of the coefficient of drag (C_D) vs Mach number, specifying reference area (A), weight (W), and volume (V) for pieces resulting from destruct action. A piece that in the absence of wind travels a maximum distance, and major piece(s) that in the absence of wind travel a minimum distance must be included. If drag coefficient curves for vehicle pieces cannot be estimated satisfactorily, the subsonic and supersonic W/C_DA for each major piece is provided instead. In either form, three sigma tolerance limits for the drag coefficients given for the maximum distance piece should be included. For major pieces that can possibly stabilize during free flight, drag coefficient curves should be provided for this angle of attack. If

the angle of attack where stabilization occurs is other than zero degrees, a lift coefficient (C_L) vs Mach number curve should also be provided for this angle. In addition, drag coefficient estimates are required for vehicle pieces of minimum W/C_DA, such as missile skin, or fuel tank sections. All C_D and C_L vs Mach number curves must be provided in graph form. Include equations for these curves if available.

2.5.4.2.3. Estimates of incremental velocities imparted to the vehicle pieces that drag data are required for in 2.5.4.2 above.

2.5.4.3. Furnish a description of the effects of explosive warheads, if applicable. This description includes, but is not limited to, location and altitude of the point where detonation is intended, effects of detonation on the missile and warhead (dispersion of missile and missile pieces), and dispersion of fragments of warhead. The description should also include diffusion and dispersion of any toxic or radioactive clouds or fragments and the radiation and exposure characteristics.

2.5.5. This paragraph provides background information and details about the trajectory requirements set forth in 2.5.2 above.

2.5.5.1. The nominal or reference trajectory is the trajectory the missile would fly if all vehicle parameters were exactly as expected, all vehicle systems performed exactly as planned, and there were no external perturbing influences.

2.5.5.2. The three sigma maximum and minimum altitude trajectories define for any ground range the limits of normality as far as altitude is concerned. In other words, for any particular ground range, approximately 99.7 percent of all normal missiles (assuming a normal distribution) have altitudes between the extremes achieved at that point by three sigma maximum-altitude and three sigma minimum-altitude missiles. Any deviation outside these limits indicate the missile is behaving in an abnormal, though not necessarily dangerous, manner. However, the safety officer may destroy such a missile if it is approaching a land mass or threatening to get outside or below the command destruct coverage area.

2.5.5.3. The three sigma lateral trajectory defines the lateral limits within which 99.7 percent of all normal missiles are expected to remain. A missile that deviates outside these limits is subject to possible destruction as discussed for the maximum and minimum altitude trajectories.

2.5.5.4. The three sigma high-performance trajectory should define the vehicle capability limits in climbing to maximum altitude at the maximum possible rate.

2.5.5.5. In computing the three sigma trajectories, those parameters having a significant effect upon vehicle dispersion (such as thrust, specific impulse, wind weight, and atmospheric density) should be combined in the way best to produce the required trajectories. A brief discussion of the assumptions and calculations made in deriving these trajectories must be provided.

2.5.6. For air-launched cruise missiles, the data requirements outlined in 2.5.1 thru 2.5.5.5 above and paragraph 2.9 are applicable in addition to the following:

2.5.6.1. Type of launch aircraft.

2.5.6.2. Description of drop aircraft flight plan.

2.5.6.3. Aircraft flight azimuth (degrees true), speed (ft per sec), altitude (ft) at launch and path angle of velocity vector relative to local horizontal (deg) at launch.

2.5.6.4. For other than level flight launches, a statement on how the aircraft path angle and the launch azimuth are determined for vehicle release.

2.5.6.5. The maximum region around the drop point where drop can occur. This is provided as distances downrange, uprange, and crossrange relative to the expected drop point, along and perpendicular to the launch azimuth, or by providing the geodetic latitude and longitude of the corners of the drop box.

2.5.7. A statement of vehicle performance is required within one to three months after a failure has occurred during a missile test. This information is provided by written letter or by sending WSMC/SE the performance evaluation documents prepared for other purposes. Information required includes:

2.5.7.1. Qualitative statement about the performance of each stage and the various subsystems.

2.5.7.2. Failures that occurred and resulting flight conditions produced.

2.5.7.3. Probable cause of failures and corrective action taken.

2.5.7.4. Impact points for stages.

2.5.7.5. Miss distances for weapons systems tests.

2.5.7.6. Comparison of planned and achieved cutoff conditions for each stage.

2.5.7.7. Performance of on-board safety instrumentation systems.

2.6. Small Rocket Data Requirements. The trajectory and performance data requirements set forth in this part apply to all small rockets. Small rockets are not required to carry destruct systems when dispersion analysis and control of launch conditions indicate that the vehicle and debris can be contained within predetermined safe areas. Lead time requirements are listed in paragraph 2.3.

2.6.1. The following vehicle related items are required for each rocket flight or group of similar flights.

2.6.1.1. General information concerning the purpose of mission, number of launches in program, brief description of payload giving weight, and nature of data to be obtained.

2.6.1.2. Scaled diagram of vehicle.

2.6.1.3. Latitude and longitude of launcher.

2.6.1.4. Desired launch azimuth and launch elevation angle giving the variation in azimuth and elevation angle that is acceptable from the standpoint of mission accomplishment. Indicate which mission objectives actually determine the acceptable limits for azimuth and elevation angle.

2.6.1.5. A brief description of the type of launcher is required and should include whether it is a zero length or short rail type, the amount of effective guidance, adjustments available in quadrant elevation (QE), azimuth, and the smallest measurement for these adjustments.

2.6.1.6. Total vehicle weight and propellant weight of stages at lift-off.

2.6.1.7. Coefficient of drag (C_D) vs Mach number, giving reference area (A) and weight (W) for expended stage or stages and for payload. Curves must cover Mach number

range from zero up through maximum values expected. Also indicate whether bodies are stable and, if so, at what angle of attack, and state briefly how drag curves were determined.

2.6.1.8. Required dispersion data:

2.6.1.8.1. As the three sigma dispersion area is used as the impact area, a careful dispersion analysis is a necessity. The following factors should be considered in determining the three sigma dispersion of a predicted impact point:

2.6.1.8.1.1. Variation in thrust.

2.6.1.8.1.2. Error in drag estimates.

2.6.1.8.1.3. Thrust misalignment.

2.6.1.8.1.4. Fin misalignment.

2.6.1.8.1.5. Variation in weight.

2.6.1.8.1.6. Variation in ignition time of stages.

2.6.1.8.1.7. Impulse error.

2.6.1.8.1.8. Tip-off and separation.

2.6.1.8.1.9. Error in wind velocity measurement.

2.6.1.8.1.10. Error in launcher setting.

2.6.1.8.1.11. Additional items of possible variation or error.

2.6.1.8.2. The three sigma variation in each of the above factors must be listed in addition to the extent these factors displace the impact point of each stage in downrange and crossrange distance from the nominal impact point, in feet or nm. The total dispersion is then estimated by statistically combining the impact displacement errors introduced by the above factors.

2.6.1.8.3. The above dispersion data must be supplied for all stages of the vehicle and payload, with a complete and detailed summarization containing the methods of computation and assumptions that were made. The same dispersion analysis is used for small changes in launcher QE and payload weight if it can be shown that the area is not significantly affected by these changes.

2.6.1.9. Required impact prediction data:

2.6.1.9.1. In most cases, wind is the largest independent factor causing displacement of unguided vehicle impact points. The following data are required to predict the magnitude and direction of this effect:

2.6.1.9.1.1. Ballistic wind weighting factors vs altitude in feet. The wind weighting factors should be presented in percent of wind effect for specific wind altitude intervals. The ballistic wind weighting factors should include both the effects of drift and weather cocking. Booster or first-stage wind drift effects are of prime importance since the booster and first stage motor impact point is usually near the launch site.

2.6.1.9.1.2. Change of the nominal impact point due to missile weather cocking and drift as a result of ballistic winds (head, tail, side, or resultant wind effect) in feet, nm or ft per sec of wind. This data varies significantly with a change in launcher QE and, therefore, must be supplied in a table of launcher QE vs unit wind effect. The table must have a minimum interval of 2 degrees and include plus and minus 12 degrees from the desired resultant QE up to a maximum launcher setting of 88 degrees.

2.6.1.9.1.3 Launcher adjustment curves to correct the launcher in azimuth and elevation for wind effects. This data is required only if the user desires to adjust the launcher azimuth and elevation to correct for wind effects, and must be supplied for all desired resultant QEs. Wind compensation minimizes the area clearance problem by maintaining a constant impact point. A thorough description of the correction method and the expected accuracies to be achieved are required in addition to the proper curves and tabulation of data.

2.6.1.9.1.4. A graphical and tabular presentation of the impact point displacement due to earth rotation vs QE. Calculations for this information are based upon the latitude of the launcher and the desired launch azimuth. The table must have a minimum interval of 2 degrees and include plus and minus 12 degrees from the desired resultant QE up to a maximum of 88 degrees.

2.6.1.9.2. When a computer program is used to perform the calculation required for adjustment of the launcher in QE and azimuth, the Range user must include a discussion of the intended use of the program. If the Range user wishes to use one of the computer programs available at the Range, consultation should be made with the Range to make sure that 2.6.1.9.1.1 thru 2.6.1.9.1.4 above, are presented in a form compatible with the necessary computer input.

2.6.1.9.3. The tabulations and charts of 2.6.1.9.1.1, 2.6.1.9.1.2, and 2.6.1.9.1.4 above, are accompanied by a comprehensive discussion of their formulation and an example of their use.

2.6.1.10. If any fragments, such as spin motors or hatch covers, etc., are ejected from the vehicle during any portion of the flight, there must be a complete description of the ejection conditions and associated impact dispersion area.

2.6.1.11. All analyses for long-range probes (500 nm plus) must be calculated using a rotating spherical or ellipsoidal gravity field. Long-range probes, in contrast to the majority of probe vehicles, normally require a destruct system that is incorporated in an unguided vehicle. The data requirements are the same as those specified for guided ballistic missiles. If it can be shown that a destruct system is unnecessary for some long-range probes when launched from a definite geographical position with specific launch parameters, an impact probability study shall be submitted according to paragraph 2.2.4.

2.6.1.12. If an air-launch of a small rocket is desired, the following specific data are also required:

2.6.1.12.1. Type of launch aircraft.

2.6.1.12.2. Launch QE.

2.6.1.12.3. Launch velocity in ft per sec or Mach number.

2.6.1.12.4. Launch altitude in feet.

2.6.1.12.5. Flight azimuth.

2.6.1.12.6. Geodetic latitude and longitude of the expected drop point. In addition to the expected drop point, the maximum region around this point where drop could occur should be defined. This is provided in distances downrange, uprange, and crossrange relative to the expected drop point or by providing the geodetic latitude and longitude of the corners of the drop box.

2.6.1.12.7. For launchers other than level flight, a writeup on the method of determining the launch QE and launch azimuth for vehicle release.

2.6.1.12.8. Nominal flight profile for each stage from launch to impact, showing altitude in feet vs downrange in feet, with timing marks in seconds indicated on the profile. Profiles must be included for all unignited or nonseparation conditions of the vehicle.

2.6.1.13. Summary of past vehicle performance giving number launched, launch location, number that performed normally, behavior and impact for any that malfunctioned, and nature of malfunction and corrective action.

2.6.2. The following trajectory data are required for the nominal trajectory for each desired nominal QE angle and payload weight, from launch until burnout of the final stage. These data must be provided in a tabular form with the independent variable, time in seconds, appearing on each sheet and with each column of the table containing only a single parameter. This table is a direct printout from the computer used to calculate the trajectory; however, it must conform with the table format specified. A definition of symbols must accompany each set of data. Time must be given at even intervals, not to exceed one second increments during thrusted flight, and for times corresponding to ignition and thrust termination or burnout of each stage.

2.6.2.1. Velocity in ft per sec vs time of flight.

2.6.2.2. Altitude in feet vs time of flight.

2.6.2.3. Ground range in feet vs time of flight.

2.6.2.4. Flight path angle of the total velocity vector in degrees vs time of flight.

2.6.2.5. Coriolis displacement of the impact point should be presented, if it has been omitted in the trajectory data calculations.

2.6.2.6. In addition to the tabular nominal trajectory information, the following characteristic vehicle data are required in graphical format:

2.6.2.6.1. Impact range vs launch elevation angle for each stage and payload (nm vs deg).

2.6.2.6.2. Apogee altitude vs launch elevation angle for each stage and payload (ft vs deg).

2.6.2.6.3. Ground range vs altitude for each stage and payload (nm or ft vs ft).

2.6.3. A statement of vehicle performance is required within one to three months after a vehicle test has been conducted. This information may be provided by writing a letter or by loaning WSMC/SE the performance evaluation documents prepared for other purposes.

2.6.3.1. Qualitative statements about the performance of each stage and the various subsystems.

2.6.3.2. Failures that occurred and resulting flight conditions produced.

2.6.3.3. Probable cause of failures and corrective action taken.

2.6.3.4. Vehicle type and number, launch date, launch location, test number, payload type and weight.

2.6.3.5. Actual launcher azimuth and elevation setting (degrees).

2.6.3.6. Predicted range (nm) and azimuth (deg) from the launcher to the impact point for each stage and payload. The predicted range and azimuth is based upon the predicted winds at time of launch.

2.6.3.7. Actual range (nm) and azimuth (deg) from the launcher to the impact point for each stage and payload.

2.6.3.8. Actual impact range components (nm) for each stage and payload measured along and perpendicular to the predicted impact azimuth. Where a stage is not tracked to impact, the impact point is computed using the best estimates of the drag characteristics and of the winds at launch.

2.6.3.9. Predicted effective QE (deg) of trajectory for each stage.

2.6.3.10. Actual effective QE (deg) of trajectory for each stage.

2.6.3.11. Predicted range (nm) and altitude (ft) of apogee for each stage.

2.6.3.12. Actual range (nm) and altitude (ft) of apogee for each stage.

2.6.3.13. A tabulation of the reduced wind data used to make the launcher setting calculations giving speed (ft or sec) and direction (deg) as a function of altitude (ft).

2.6.3.14. A reference list of all documents, graphs, and tabulations used to make the launcher setting calculations, that is, wind weighting curves, ballistic wind weighting factors, unit wind effect, tower tilt factor, etc.

2.6.3.15. Source of tracking data.

2.7. Aircraft Drop Data Requirements. The data requirements set forth under this heading apply to all nonpropulsive objects dropped ballistically or by parachute from an aircraft. Lead time requirements are listed in paragraph 2.3.

2.7.1. For general vehicle data, the following data are required for each test or group of tests:

2.7.1.1. General information concerning the purpose of the test, description of the object, and the type of data that are obtained.

2.7.1.2. Geodetic latitude and longitude of the desired drop point and impact point. In addition, the maximum region around these points where drop or impact could occur should be defined. This is provided in distances downrange, uprange, and crossrange relative to the expected drop point or by providing the geodetic latitude and longitude of the corners of the area.

2.7.1.3. C_D vs Mach number, reference area, and weight of object being dropped. The distance traveled in the horizontal direction from the point of release to impact can be supplied instead of the drag information.

2.7.1.4. The effect on the location of the impact point due to winds blowing in the direction of drop and perpendicular to the direction of drop is specified as distance per knot of headwind or crosswind.

2.7.1.5. Three sigma dispersion or circular error probability (CEP) of impact point. If pilot error is not included in this dispersion, provide as a separate dispersion.

2.7.2. Flight plan of the drop aircraft. This includes the altitude of the aircraft, true air speed, and dive angle beginning 60 seconds prior to drop and continuing through drop. The required profile trajectory of the drop is in altitude in feet vs downrange distance in feet. Trajectories are included with parachute opening and with parachute not opening. Timing marks in seconds are indicated on the trajectory, a. well as total time of flight for each object dropped.

2.8. Aircraft and Ship Sensor Support Plan Data Requirements. For missile launch or reentry operations requiring support aircraft or ships, the followng additional information is required:

2.8.1. Aircraft Flight Profile Information:

2.8.1.1. The following information must be submitted to WSMC/SEY at least 30 calendar days before the intended operation.

2.8.1.1.1. Type of aircraft.

2.8.1.1.2. Call sign ("N" number, tail number, etc.).

2.8.1.1.3. Final staging and recovery base.

2.8.1.1.4. Warning area and mission area penetration (entry and exit) point(s).

2 8.1.1.5. Holding fix(es) and altitude(s).

2.8.1.1.6. Course, speed and altitude(s) to the test support position (TSP), that is, terminal end of the data run.

2.8.1.1.7. Maneuvering after TSP for departure to recovery base.

2.8.1.1.8. A copy of information supplied in Federal Aviation Agency (FAA) and other required flight plans for controller background information.

2.8.1.2. A copy of information, both written and graphic, describing the data gathering maneuvers to be conducted while operating in an area controlled by the supporting Range.

2.8.1.3. Prior to the start of the operation, each aircraft commander receives an operation identifier, for example, operation number, that must be included in the FAA flight plan remarks section at the time of filing.

2.8.2. Ship Cruise Profile Information:

2.8.2.1. The following information must be submitted to WSMC/SEY at least 30 calendar days before the intended separation.

2.8.2.1.1. Class of ship.

2.8.2.1.2. Call sign (registration number, name, etc.).

2.8.2.1.3. Final staging and recovery point.

2.8.2.1.4. Warning area and mission area penetration (entry and exit) point(s).

2.8.2.1.5. Holding fix(es).

2.8.2.1.6. Course and speed to the test support position (TSP), that is, terminal end of the data run.

2.8.2.1.7. Maneuvering after TSP for departure to recovery point.

2.8.2.1.8. A copy of information supplied in sailing orders for controller background information.

2.8.2.2. A copy of information, both written and graphic, describing the data gathering maneuvers to be conducted while operating in an area controlled by the supporting range.

2.9. West Coast Offshore Operating Area (WCOOA):

2.9.1. General information concerning the nature and purpose of the flight. In addition to the items required in paragraph 2.8, the following items are required for aircraft flight:

2.9.1.1. List associated aircraft (chase, tanker, etc.) by type(s) and "N" or tail numbers.

2.9.1.2. Specify minimum weather requirements for test operations.

2.9.1.3. Specify special emergency requirements.

2.9.1.3.1. Search and Rescue (SAR) support requirements.

2.9.1.3.2. Emergency Recovery Plan. Include minimum field length(s).

2.9.1.3.3. Describe ditching characteristics, if known.

2.9.1.3.4. Describe secondary communication procedures to be used in the event of primary communications failure.

2.9.1.3.5. If structural flight and systems tests are to be conducted, specify any weather minimums and special requirements.

2.9.1.3.6. A sonic boom report is required if sonic boom testing is to be conducted in compliance with AFR 55-34, Reducing Flight Disturbances, and file AF Form 121, Sonic Boom Report.

2.9.1.3.7. For environmental assessment, comply with AFR 55-34 and AFR 19-2, Environmental Impact Analysis Process (EIAP).

2.9.1.3.8. Range users should comply with WSMCR 55-7, Aircraft and Aeronautical Systems Testing on the WCOOA.

2.9.2. For SABER, three types of input data are required. These are control information, NFS data, and flight profile data.

2.9.2.1. Control information required:

2.9.2.1.1. R - distance from aircraft where NFS is determined, in feet.

2.9.2.1.2. LM - length of model of vehicle in feet.

2.9.2.1.3. LR - vehicle aircraft length in feet.

2.9.2.2. NFS data:

2.9.2.2.1. (theta) - roll angle, in degrees.

2.9.2.2.2. M - Mach No.

2.9.2.2.3. N - number of points in NFS.

2.9.2.2.4. X - Aircraft station on model where pressure perturbation was measured in feet.

2.9.2.2.5. Delta P/P - pressure perturbation divided by ambient pressure.

2.9.2.3. Flight profile data:

2.9.2.3.1. Time (seconds).

2.9.2.3.2. Vehicle altitude (feet) above reference spheroid.

2.9.2.3.3. Geodetic latitude (degrees) of vehicle.

2.9.2.3.4. Longitude (degrees) of vehicle.

2.9.2.3.5. Vehicle freestream Mach number.

2.9.2.3.6. Vehicle flight path angle (degrees) measured up from horizontal.

2.9.2.3.7. Vehicle heading (degrees) from true north.

2.9.2.3.8. M dot - The time rate of change of Mach number (1 second).

2.9.2.3.9. Time rate of change of flight path angle (degrees or second).

2.9.2.3.10. Time rate of change of heading (degrees or second).

2.9.2.3.11. Roll angle (degrees) from horizontal up to right wing. Wing as viewed from behind the vehicle.

2.10. Directed Energy Systems. The data requirements set forth under this heading applies to all forms of directed energy system testing. These systems include, but are not limited to, lasers, neutral and ion beams with any combination of surface, air or space for the energy source or target. Lead time requirements are listed in paragraph 2.3, however, some systems may require more advanced lead time.

2.10.1. The following data are required for each test or group of tests. Additional data may be required depending on the system being tested.

2.10.1.1. General information concerning the purpose of the test, description of the system, and the type of data that is obtained.

2.10.1.2. Location of energy source and target. In addition, the maximum region around these areas that are hazarded should be defined.

2.10.1.3. The type of primary and secondary radiation, if present. The effect of the radiation, permissible exposure levels, hazardous range, both endoatmospheric and exoatmospheric.

2.10.2. The trajectory of the energy source, the beam, the target, and timing are required.

2.10.3. Coordination with Space Defense Operation Center (SPADOC) is required for systems that may present a hazard to a spacecraft. For these systems, test day coordination with SPADOC will be required to verify clear range. A test plan will be developed by the range user and exercised prior to test day to verify timely operational control.

Chapter 3

SYSTEM GROUND SAFETY

3.1. System Ground Safety Introduction:

3.1.1. This chapter encompasses policy, responsibility, unique design, and data requirements for system and design safety, including the prelaunch portion of missile and space operations. Data submittals and procedures are defined for obtaining safety approvals and MSSSA for ground processing, launch, and recovery of missile systems.

3.1.2. The chapter identifies the system safety policies and requirements that are to be implemented by the user and Government sponsor. Satisfactory demonstration or evidence that these requirements have been met is a user responsibility. Actual implementation is delegated to a contractor activity, but failure of a contractor to comply, or failure to provide contractual direction, does not relieve the sponsor of the responsibility. The Government sponsor must make sure that the responsibility is implemented. Tailoring of these requirements must be coordinated with WSMC/SE.

3.1.3. It is the responsibility of all users to provide for the safety of their systems. Compliance with requirements of this chapter provides the level of safety required for design and system processing. Mishap risks can be independently accepted by the user only when the effects of the mishap are contained totally within user-controlled resources. If the effect of a mishap generates damage across an interface to resources under the control of another agency, mishap risks are accepted only with the concurrence of the affected agencies and the highest management authority participating in the operation.

3.1.4. It is the responsibility of the user to independently verify and present evidence to WSMC/SE that safety requirements are implemented. This presentation identifies methods used to effectively control mishap risk, within the parameters specified by this chapter, for review by WSMC/SE. Acceptable verification methods include design specifications, engineering drawings, control procedures, documented inspections, and test results. WSMC/SE must be assured that user operation does not present a hazard that will injure personnel or cause damage to WSMC property.

3.2 System Safety Program:

3.2.1. An analysis program, such as described in MIL-STD-1574A, will be conducted for each system operated at WSMC. The criteria of this chapter complements the system safety criteria contained in MIL-STD-1574A and will be implemented in system design and system safety analysis.

3.2.2. A System Safety Program Plan (SSPP) DI-H-7047, will be prepared according to MIL-STD-1574A, describing the safety program for installation and operation of the system at WSMC. The SSPP will depict the aspects of MIL-STD-1574A and the Accident Risk Assessment Report that are pertinent to the program. WSMC/SE will be provided copies of the SSPP with the initial request according to MIL-STD-1574A, describing the safety program for installation and operation of the system at WSMC. WSMC/SE will be provided copies of the SSPP with the initial request for Range use.

3.2.3. WSMC/SE must have representation in the system safety groups formed by hardware and software design agencies for systems to be used at WSMC. Notice of technical interchange meetings and program reviews (PDR, CDR, etc.) will be provided to WSMC/SE. WSMC/SE representatives will attend the meetings of interest on a selective basis.

3.2.4. The user must establish procedures for identification and timely action for eliminating or controlling hazardous test conditions induced by design deficiencies, unsafe acts, or procedural errors. Procedures must be established to identify, review, and supervise hazardous high risk tests, including tests performed specifically to obtain safety data. The user's system safety organization must:

3.2.4.1. Review and approve test plans, procedures, and changes to verify safety requirements identified by the system analysis are incorporated.

3.2.4.2. Make sure an assessment of accident risk is included in all pretest readiness reviews.

3.2.5. Users must provide a Launch Complex Safety Plan (LCSP) according to chapter 5. Payload organizations normally supplement existing plans.

3.2.6. The user's system(s) must be designed to tolerate a number of credible failures or operator errors as determined by the degree of hazard involved in the operation(s). All sequences, procedures, or functions which operate under computer control shall be designed in such a manner that a critical failure mode or error condition will result in the system reverting to a known safe state.

3.2.6.1. Ordinary operations are those having mishap potential, but normal industrial safety practices are sufficient to prevent mishap occurrence. (Design safety factors for slings, hoists, cranes, etc., are considered sufficient protection.) During ordinary operations, all systems must remain at least two failures from a class B mishap (single-fault tolerant) and three failures from a class A mishap (two-fault tolerant).

3.2.6.2. No single failure, or operator error, should result in damage to equipment, injury to personnel, or the use of contingency or emergency procedures (class B mishap, or less, as defined in AFR 127-4, Investigating and Reporting US Air Force Mishaps). Operations that could result in a class B mishap must have at least two independent inhibits in place during all periods when the potential for mishap exists. Loss of one inhibit requires suspension of the operation until the inhibit is restored. Analysis may show that limited exposure of personnel is reasonable and prudent when one inhibit has been removed and the likelihood of failure of the remaining inhibit is remote. If this exposure is permitted, the operation is designated as a type B hazardous operation and all personnel not essential for conduct of the particular task are evacuated.

3.2.6.3. No combination of two failures or operator errors should cause a fatality or result in major damage (class A mishap as defined in AFR 127-4). Operations that could result in a class A mishap must have at least three independent inhibits in place during all periods when the potential for mishap exists. Loss of one inhibit requires suspension of the operation until the inhibit is restored. Analysis may show that limited exposure of personnel is reasonable and prudent when one inhibit has been removed and the likelihood of failure of the remaining inhibits is remote. If this exposure is permitted, the operation is designated as a type B hazardous operation and all personnel not essential for conduct of the particular task are evacuated. If analysis shows exposure is not reasonable and prudent when one inhibit has been removed or if two inhibits have been removed, all personnel will be evacuated from the hazardous area. In this event, the operation is designated a type A hazardous operation.

3.2.7. As part of the accident risk factor identification and control matrix in the Accident Risk Assessment Report (ARAR), users will apply definitions of hazard categories as follows:

3.2.7.1. Category III hazards exist in conditions where the worst case potential effect is less than category I or II hazards described below.

3.2.7.2. Category II hazards are those that could result in:

3.2.7.2.1. Personnel injuries.

3.2.7.2.2. Damage to launch site equipment or facilities or launch vehicle payload.

3.2.7.2.3. Conditions that result in a system being one event (failure or human error) away from a category I hazard.

3.2.7.3. Category I hazards are those that could result in:

3.2.7.3.1. Loss of life.

3.2.7.3.2. The loss of major systems such as missile, payload, a launch facility, or support facility.

3.2.7.3.3. Missile impact outside the hazard corridor.

3.2.8. Residual hazards are conditions that retain the potential of causing injury to personnel, or damage to equipment, after intended design or other control actions have been implemented to reduce the probability and consequences.

3.2.8.1. Hazardous operations are those that contain category II residual hazards. Such hazards could result in class B mishaps.

3.2.8.2. Dangerous operations are those that contain category I residual hazards. Such hazards could result in class A mishaps.

3.3. MSGSA Requirements:

3.3.1. All ground support equipment (GSE), facilities, missile and space systems, critical software modules, computer controlled test equipment, computerized maintenance scheduling systems, and modifications to these systems for all hazardous operations must be reviewed and receive safety approval for use at WSMC. To obtain approval, users must meet the requirements of this regulation. MSGSA is the approval means for operation of any missile and space vehicle at WSMC. Formal MSGSA is granted after all data submittals have been received, reviewed, and approved.

3.3.2. When proposed missile and space vehicle systems are approved for operation, the launch agency is given a MSGSA specifying the conditions of approval and the particular vehicle(s) the approval applies to. The approval is effective as long as the designated systems remain in the specified limits. MSGSA constitutes approval for hazardous ground operations up to and including launch. MSGSAs are not repetitive. A MSGSA is required prior to each launch of a continuing program. Certification that the system configuraation has not changed is required prior to the issuance of each MSGSA, or the changes must be submitted as a part of the request for MSGSA.

3.3.3. An ARAR provides verification of safe system design and planned safe operation. It is the basis for issuance of the MSGSA. The ARAR is prepared according to Data Information Description (DID) DI-S-30565A. The user and Government sponsor coordinate the delivery schedule with WSMC/SE. The ARAR is required 30 days prior to conduct of hazardous or dangerous operations; 120 days if radioactive sources are to be used. A minimum of one copy of the ARAR is provided to WSMC/SE; more are required if the program size involves several safety offices. The Range user is responsible for providing required data regardless of the extent of contractor support.

3.3.3.1. Brief descriptions of the booster system, payload system, software control system, and any other systems must be provided in the ARAR introduction. Brief details of the hazardous subsystems must be provided in the ARAR appendices, 3.3.3.3 below. Safety requirements for support equipment are identified. Support equipment safety design criteria must be incorporated in the segment specifications. Special attention must be given to the planning, design, and refurbishment of reusable support equipment including equipment carried on flight vehicles to make sure safety is not degraded by continued usage. Identified requirements for support equipment must be equal to, or better than, those specified by Federal and Air Force Occupational Safety and Health (AFOSH) Regulations.

3.3.3.2. The user shall inform WSMC/SE of all hardware or software changes, modifications, and new systems that have a safety implication. The notification must be made at least 30 days prior to initiating actions for modifications or changes to existing approved programs; at least 90 days prior to bringing a new program or major system to WSMC; and at least 120 days prior to use of radioactive materials at WSMC.

3.3.3.3. Descriptions of ARAR appendices are as follows. The user's documentation should incorporate one or more of the following system appendices; if not utilized, a negative response is required in the ARAR:

GSE and Facilities - Section 3.5

Handling Equipment - Section 3.6

Noise Protection - Section 3.7

Non-Ionizing Radiation - Section 3.8

Ionizing Radiation - Section 3.9

Toxic Materials - Section 3.10

Propellant and Propulsion Systems - Section 3.11

Pressurized Systems - Section 3.12

Ordnance Systems - Section 3.13

Electrical and Electronic Systems - Section 3.14

Software/User-System Interface (USI) - Section 3.15

3.3.4. The safety requirements established in this regulation provide many design solutions to hazardous conditions. They apply generally to all systems operated at WSMC. Safety analyses may show alternate methods of hazard control more appropriate to a specific system design. Such alternate methods can be coordinated for approval with WSMC/SE during design reviews.

3.3.5. Attachment 2 is a listing of reference documents for safe design considerations. They are sources of information for requirements to be used in the system design and development of the ARAR. They should be used as much as possible and in conjunction with other recognized codes and standards. Clarifications of conflicting requirements or questions of tailoring are submitted to WSMC/SE for interpretation and final resolution.

3.4. Missile Systems and Missile Operations:

3.4.1. A brief description of the missile booster system must appear in the ARAR introduction, and brief details of the hazardous subsystems must appear in the appropriate ARAR appendices. If the program is repetitive in nature, subsequent ARARs may refer to the original ARAR and detail only those items or systems that are new or changed. A MSGSA is not repetitive, each launch of a system requires a separate MSGSA request.

3.4.2. Hazardous and dangerous missile processing, prelaunch, and launch operating procedures require WSMC System Safety approval. A description of missile processing must appear as part of the ARAR under the procedures section, as well as descriptions of system processing. The information contained in hazardous operating procedures will be as specified in paragraph 5.4.3.3. These procedures must be submitted to WSMC/SE for review and approval at least 30 days prior to beginning of operations.

3.4.3. Space Shuttle payload operations must utilize the Space Transportation System Payload Ground Safety Handbook, SAMTO HB S-100 (available from SAMTO/DO). Space shuttle payload design must conform to safety requirements cited in NHB 1700.7A.

3.5. GSE and Facilities:

3.5.1. Safety approval of facilities, missile systems, explosive siting, design, and modifications consist of:

3.5.1.1. Facility construction plans involving design, construction or modifications performed on AFSC facilities must be approved by WSMC/SE prior to start of construction. The range user or Base Civil Engineering must submit a preliminary hazards analysis with the plans to WSMC/SE. Review, coordination, and approval of support facilities, or missile systems, and modifications to them normally require a minimum of 30 days.

3.5.1.2. AFR 127-100, Explosive Safety Standards, will be used for planning, siting, constructing, operating, modifying, or relocating any ordnance, propellant, hazardous assembly and checkout, or launch complex facilities at WSMC. WSMC/SE must approve all quantity-distance (QD) site plans or proposed facilities that fall within proposed or existing explosive safety clear zones. Facility explosive quantity distance siting requires a minimum of 120 days for the review and approval processing cycle.

3.5.2. WSMC/SE may elect to participate in government buy-off of facilities.

3.5.3. Provide fire-protection systems according to sound economical and engineering practices to make sure the proper degree of fire protection for the mission and risk according to a planned program to further protect life and property. Fencing encompassing facilities where hazardous operations are performed must have emergency egress gates approved by WSMC/SE.

3.5.3.1. Use an agent application method and extinguishing agent that are both compatible and effective for the anticipated hazard.

3.5.3.2. System restoration time should be minimal in critical protection areas with repeat application capability or system redundancy considered as design objectives.

3.5.4. Air Force 88 series documents are the prime source for design direction; other Government and national consensus standards and specifications are secondary sources for facilities used in the storage, assembly, checkout, prelaunch, and launch of ordnance for missile space vehicles and payloads.

3.5.5. AFR 127-100 will be used for planning, siting, constructing, operating, modifying, licensing, or relocating any ordnance propellant, hazardous assembly and checkout, or launch complex facilities at WSMC. WSMC/SE must approve all QD site plans or proposed facilities that fall within proposed or existing explosive safety clear zones.

3.5.6. Once hazardous systems are approved, their components and interfaces with other systems must not be modified without prior WSMC/SE approval. If modifications are made without prior coordination, SE approval is automatically revoked. The procedure for obtaining approval for modification is the same as for a new system. Changes must conform to current safety requirements at the time of the change and not necessarily to the requirements of the original design.

3.5.7. Special hazardous operations (those not directly associated with missile test, WSMC operations, or normal WSMC operations and maintenance (O&M) functions, but employing WSMC resources) will be conducted using an approved test plan or special test procedures. The proposed test plan or special test procedures must be submitted to WSMC/SE for approval. Those operations that require services of other Air Force commands or federal agencies may require review and approval by the organization providing the service. Such approval is also coordinated through WSMC/SE.

3.5.8. All changes to previously approved hazardous procedures require WSMC/SE approval.

3.5.9. When an operation could cause damage to equipment, injury to personnel, or degradation of system functions, particular attention must be given to controls.

3.5.9.1. Operation of controls that initiate hazardous operations require prior operation of an associated or locking control. When practical, the critical position of such a control activates a visual and auditory warning device in the affected work area. Public address (PA) announcements are mandatory for the start of hazardous or dangercus operations and should be used to terminate safety control areas when operations are complete.

3.5.9.2. Deadman controls must be utilized when operator incapacity can cause an immediate safety-critical system condition.

3.5.9.3. Systems must have sufficient assistant operators or spotters to make sure that all sides of the system are clear for operation. All operators or spotters must have aural communications available for coordination between themselves when power is on the system.

3.5.9.4. If system movement could be critically hazardous from the view of a spotter or assistant operator, an emergency stop capability must be available at each such viewpoint.

3.5.9.5. For systems where concurrent commands can be made, priority is provided for the superior command, or the control station must be provided with a disconnect or key lock-out feature. The lock-out feature must not preclude the emergency stop capability.

3.5.10. Lifeline or lanyard anchor points:

3.5.10.1. The following is provided for determining the adequacy of anchorage points for lifelines, lanyards, or droplines and is based on criteria established in ANSI A10.14.

3.5.10.2. The anchor points shall be capable of withstanding a deadload of 5400 lbs to yield for each user of the anchor point.

3.5.10.3. The integrity of anchor points shall be determined by design analysis or by acceptance of vendor design specifications. If these methods are not possible, or the quality of fabrication is in question, the anchor points shall be proofload tested to 2160 lbs for each user of the anchor point.

3.5.10.4. Design analysis and proofload shall consider all possible vectors of the forces induced by fall. The design analysis or proofload shall be repeated if the anchor point becomes damaged, modified, or repaired.

3.5.10.5. The anchor points shall be stenciled or tagged with the maximum number of persons and total weight allowed to be attached to the anchor point at a given time.

3.5.10.6. The anchor points will be located as high as practical to limit the distance of potential fall.

3.5.10.7. Fixed anchor points shall be located so that they do not endanger fluid or gas lines, electrical cabling, critical hardware, or flight components when the lifeline or lanyard is attached, in use, or under load. To preclude the above conditions, shielding or guarding of the components or systems in question may be required.

3.5.10.8. Anchor points other than those existing and designated may be approved if they are verified to comply with the above criteria. Additional fixed anchor points may use existing structures which comply with the stated requirements stated here when approved by WSMC/SE.

3.6. Handling Equipment:

3.6.1. Validation tests will be accomplished on all elevators according to the requirements of the American National Standards Institute (ANSI) A17.1 and ANSI A17.2, as amended or updated.

3.6.2. The following applies to forklifts used for handling critical loads:

3.6.2.1. The design must provide for proof testing to 125 percent of rated load.

3.6.2.2. If the forklift is for operation outside, a tire size capable of negotiating the expected ground terrain is needed. The forklift should be capable of "field stacking."

3.6.2.3. Diesel and gasoline powered forklifts must have the following features:

3.6.2.3.1. Exhaust system spark arrestors.

3.6.2.3.2. Tight-fitting caps on the fuel-fill pipes.

3.6.2.3.3. A deflector plate to prevent fuel overflow from hitting motors or exhaust components.

3.6.2.3.4. Fuel line valves, installed at fuel tanks for emergency flow shutoff, and flash screens in the fill lines.

3.6.2.3.5. Special fuel line vibration-protective devices must be tested for rupture under normal operating conditions.

3.6.2.3.6. Electrical connections designed to preclude accidental disconnection during normal operation of forklifts.

3.6.2.3.7. Exhaust gases from any motor must be emitted at least six feet away from any ordnance loads.

3.6.2.3.8. On-board fire extinguishers must be provided for use on class B fires.

3.6.2.4. Battery-powered forklifts must meet the following criteria:

3.6.2.4.1. Electrical cables must be routed so they cannot catch or snag on stationary objects. Cables must be protected from short circuiting.

3.6.2.4.2. Battery boxes must be securely fastened and sufficient ventilation provided to assure an explosive-gas-mixture does not develop. Vent openings are designed to prevent direct access to the cell terminals from the outside.

3.6.2.4.3. Forklifts must be equipped with a deadman switch and the main service switch must be located so it can be operated from the driver's position.

3.6.2.4.4. The battery-powered units designated "EE" or "EX" must be used in locations where volatile, flammable liquids or gases are handled, processed, or used.

3.6.3. Vehicles used for transporting explosive, toxic, or hazardous materials must comply with Department of Transportation (DOT) regulations.

3.6.3.1. Motor vehicles or equipment with internal combustion engines used for transporting exposed explosives (including explosive scrap, waste, or items contaminated with explosives) must be equipped with exhaust system spark arrestors and carburetor flame arrestors (authorized air cleaners).

3.6.3.2. Vehicles with internal combustion engines, operated within a no smoking area, propellant holding area, or pad deck involved in missile servicing during or after propellant loading, or during Solid Rocket Motor (SRM) stacking, must be equipped with spark arrestors and carburetor flame arrestors (authorized air cleaners).

3.6.4.. The handling equipment section of the ARAR should list the design proofload criteria for all transportation and handling equipment according to chapter 5.

3.7. Noise Protection:

3.7.1. Noise protection design for operator personnel is implemented according to criteria outlined in AFSC DH 1-3, MIL-STD-1472C, and AFR 161-35, Hazardous Noise Exposure. Objectives of hearing protection in facility designs are to minimize short and long term hearing loss, increase task efficiency, improve communications, and reduce operator fatigue.

3.7.2. The user must include, as part of the ARAR, the location of all noise source fields that may result in hazardous noise exposure for personnel. The user must include data on the operating acoustic level and characteristics of systems or subsystems such as hydraulics, power units, and similar high energy noise producing systems when they exceed 84 decibels/A scale (dBA).

3.7.3. When individuals are exposed two or more times in a given workday to noise fields different in level for a different time interval (the duration of the interval of a specific noise level being less than the limiting duration), the acceptability of such multiple exposure to unprotected personnel can be calculated as follows (AFR 161-35):

3.7.3.1. For each separate noise field, construct a fraction by dividing the daily duration of the noise field at its specified noise level by the limiting daily duration at that specific noise level.

3.7.3.2. Add the fractions for all noise fields.

3.7.3.3. If the sum of the fractions is one or less, the exposure level is acceptable.

EXAMPLE: One noise field at 80 dBA for 8 hours, a second noise field at 88 dBA for 1 hour, and a third noise field at 100 dBA for 10 minutes. The sum would be 8/16 + 1/4 + 1/3 = 13/12. Since the fraction is greater than one, the limiting value is exceeded and the mixed exposure is unacceptable. If the duration of the noise field at 100 dBA were reduced to 7.5 minutes, sum would be 8/16 + 1/4 + 1/4 = 1 and the mixed exposure would be acceptable.

3.7.4. A method of protection must be provided for personnel who are exposed to sound pressure levels above 84 dBA in any octave band for continuous daily exposure of 8 hours per day, 40 hours per week. AFR 161-35 serves as the guide for determining the effectiveness of protection equipment and methods. Unprotected noise exposure should never exceed 115 dBA for any exposure period. No one should be exposed to noise levels that exceed 150 dBA no matter how much the noise level in the ear canal has been reduced.

3.8. Non-Ionizing Radiation:

3.8.1. Radio Frequency (RF) Systems producing RF radiation, must be designed so the hazards presented to personnel are at the lowest practical level. Personnel exposure to radiation must not exceed the permissible exposure levels of 10 milli-watts/sq. cm. or as defined in AFOSH STD 161-9.

3.8.1.1. When feasible, interlocks should be utilized to prevent unnecessary exposure of personnel to hazardous areas. Interlocks must be utilized in areas where electrical radiation hazards would be present if protective coverings were removed.

3.8.1.2. Appropriate "fail-safe systems" will be incorporated so that accidental operation of RF emitting systems is prevented.

3.8.2. A list of all radiating sources within launch complexes and ground processing locations will be provided with the information required by AFOSH STD 161-9.

3.8.2.1. When RF radiating equipment is to be introduced into range environments, a facility siting hazard analysis must be accomplished according to AFR 100-6, Electromagnetic Interference and Radiation Hazards, AFOSH STD 161-9, and TO 31Z-10-4. This analysis must be submitted to WSMC/SE for review. Test acceptance approvals may include a field survey of the RF power density. A copy must be posted at each facility and two copies will be forwarded to WSMC/SE for file and distribution.

3.8.3. Laser system designs must incorporate requirements of AFSC DH 1-6 and AFOSH STD 161-10 or rationale must be shown for nonapplication.

3.8.3.1. For areas where electrical or laser hazards would be present if protective coverings or proper eye protection were removed, interlocks must be utilized to prevent unnecessary exposure of personnel to laser hazards.

3.8.3.2. Appropriate systems must be incorporated to prevent inadvertent or accidental operation.

3.8.3.3. When toxic chemicals or cryogenic materials are utilized with laser systems, shutoff valves must be provided in locations to minimize leakage in the event of a line rupture.

3.8.3.4. Laser systems must be designed so hazards to personnel and equipment are at the lowest practical level. All laser systems must conform to the laser health hazards control specified by AFOSH STD 161-10.

3.8.4. The facility user must submit copies of the following information for laser systems as an appendix to the ARAR:

3.8.4.1. Laser specifications data sheet (including nomenclature), maximum and minimum power output, pulse durations, power measurements before and after optics, beam diameter with variations due to optics such as converging lenses, beam divergence angle, warnings, and fail-safe provisions.

3.8.4.2. A hazard analysis addressing chemical, electrical, X-ray, optical and other related hazards. It must include the calculated Safe Eye Exposure Distance (SEED) data showing that permissible exposure level (PEL) is controlled and not exceeded, and the aspects and effects of weather, reflectivity, "hot spots," and ordnance considerations.

3.8.4.3. Standard Operating Procedures (SOP) detailing operations, personnel and eye protection, and personnel access controls.

3.8.4.4. Certification for laser systems installation and operation at WSMC must be implemented through the USAF Hospital Bioenvironmental Engineering Office (USAF Hospital/SGPB).

3.9. Ionizing Radiation:

3.9.1. Radioactive system or subsystems must conform to requirements of AFR 122-15, Nuclear Power System Safety Reviews and Surveys; AFR 122-16, Nuclear Safety Review Procedures for Space or Missile Use of Minor Radioactive Sources; AFR 160-132, Control of Radiological Health Hazards; CFR Title 10; CFR Title 49; TO 00-110N-2 and 3; and MIL-STD-1574A as supplemented. The Air Force Weapons Laboratory (AFWL) is responsible for conducting a technical nuclear safety evaluation (TNSE) using the Safety Analysis Summary (SAS) submitted by the user. This evaluation is the basis for WSMC approval. The request for TNSE must be submitted through AFSC/IGF according to AFR 122-16.

3.9.1.1. Nuclear radioactive sources carried aboard missile or space vehicles must be compatible with, and have no adverse effects on, ordnance items or flight termination systems.

3.9.1.2. Nuclear radioactive sources aboard missile or space vehicles should be designed so they may be installed as late as possible in the countdown, particularly if personnel are required to work within controlled radiation areas (2mR/hr) while performing any tasks.

3.9.1.3. Design and task sequencing will be so that personnel exposure is as low as practicable and according to AFR 161-8, Control and Recording Procedures Occupational Exposure to Ionizing Radiation, CFR 10, and AFR 160-132.

3.9.1.4. The system must be designed to minimize the radiological accident risk potential in the event of a launch facility accident involving the launch vehicle. The SAS must contain location estimates of the source and its physical characteristics (vaporizes, melts, etc).

3.9.2. Two final copies of a SAS and Radiation Protection Plan (RPP), prepared according to AFR 122-16, Nuclear Safety Review Procedures for Space or Missile Use of Radioactive Sources, must be submitted to WSMC/SE 120 days prior to arrival of the radioactive material at WSMC. A SAS is required regardless of security classification. If there are no radioactive sources associated with a program, a negative response is

required. Non-Air Force users are required to certify that their flight approval requirements have been met. Copies of their approval correspondence must be provided to the WSMC Radiation Safety Committee.

3.9.2.1. Radioactive material or assemblies are handled under the supervision of a designated user or the Radiation Protection Officer named on the Nuclear Regulatory Commission (NRC) license or USAF permit. Applications for USAF permits must be submitted to the USAF Hospital/SGPB and must include a copy of the user's NRC license. The NRC licensee or contractor must submit three copies of the NRC license with the USAF permit to WSMC/SE at least 30 days prior to planned entry to WSMC.

3.9.2.2. In addition to submission of procedures and ARAR approval action, field processing must be approved in writing by the WSMC Radiation Safety Committee. As a necessary step to obtain approval, the facility user will brief the WSMC Radiation Safety Committee on all hazards and procedures concerning the handling of their radioactive material at WSMC. A MSGSA can only be issued after receipt of written approval from the WSMC Radiation Safety Committee. An approved environmental impact statement is a prerequisite for approval of the Radiation Safety Committee.

3.9.2.3. The USAF Hospital/SGPB must have access to the source to maintain appropriate records, perform routine surveys on handling procedures associated with each source, and, where necessary, perform radiation surveys on the operational use of the material. These actions are accomplished under the surveillance of the Base Radiation Protection Officer in coordination with WSMC/SE.

3.9.2.4. Notification procedures for entry and transportation of radioactive materials on VAFB are found in VAFBR 161-1, Control of Ionizing Radiation.

3.10. Toxic Materials:

3.10.1. All toxic or corrosive materials, chemicals, and propellant materials require the following information:

3.10.1.1. A general description of the commodity in use, the hazardous qualities of the material, and data showing compliance with allowable limits for airborne vapors for workspace, workplace emergencies, and short term public exposures.

3.10.1.2. As a minimum, annual air sampling must be accomplished in each workplace where exposure exceeds one-half the eight-hour timed weighted average PEL (AFOSH STD 161-8).

3.10.2. A statement is required that personnel must not be subjected to concentrations greater than the threshold limit value (TLV) under normal circumstances. If an unplanned release of propellant or vapors occurs, all unprotected personnel must be evacuated. (TLV is the maximum allowable concentration (MAC) for an eight-hour day, five-day week of continuous exposure.)

3.10.3. Detection equipment location, protective equipment, decontamination equipment, and neutralizers must be identified. The protective equipment description must include type, make and location of breathing apparatus, type of protective clothing ensemble required, and any special handling equipment required, with instructions for use.

3.10.3.1. Respirators can be used to protect workers from exposures exceeding these PELs only under the following conditions (AFOSH STD 161-1):

3.10.3.1.1. During the time period necessary to install engineering controls or institute practices.

3.10.3.1.2. In workplaces where compliance methods are either not feasible or not feasible to an extent necessary to reduce airborne contaminant levels to the PEL.

3.10.3.1.3. During infrequent or nonroutine operations.

3.10.3.1.4. During emergencies.

3.10.3.2. The Base supporting medical facility is responsible for medical examination of personnel occupationally exposed to the chemical substances listed in AFOSH STD 161-1, Control of Inonizing Radiation.

3.10.3.3. If medical examinations are required, they should, as a minimum, include:

3.10.3.3.1. Baseline and periodic (at least annual) examinations.

3.10.3.3.2. A complete medical and chemical exposure history.

3.10.3.3.3. A biological indicator of exposure if one exists (for example, blood or urine contaminants, such as lead).

3.10.3.3.4. Only those diagnostic tests or clinical examination procedures required to detect changes in target organs of the chemical exposure involved.

3.10.3.4. Only those items of protective clothing and equipment that meet National Institute for Occupational Safety and Health (NIOSH), ANSI or Air Force accepted standards will be procured or accepted for use. WSMC/SE approval is required for all protective equipment used in support of all hazardous or dangerous operations.

3.10.3.4.1. On-the-job indoctrination covering hazards, safe practices, hazard reporting, personal cleanliness, and the use and care of protective items is accomplished by the supervisor. This training must be accomplished according to AFR 127-12, Air Force Occupational Safety and Health Program, and records maintained by the supervisor.

3.10.3.4.2. Functional managers, with assistance from safety or bioenvironmental engineering personnel, determine which jobs and work areas require eye protection, and the type of eye and face protection that must be used (such as suitable approved safety spectacles, goggles, or shields). Optometry consultation should be requested when the need is indicated in conjunction with the task.

3.10.3.4.3. Safety hats and caps provide workers protection from impact, heat, electrical, and fire hazards, and must consist of the shell and the suspension combined as a protective system. Hats or caps will meet ANSI standards for the protection required.

3.10.3.4.4. Functional managers, with the assistance of the Base Safety Officer, determine what work areas and operations require personnel to wear special foot protection. Guidance is provided in AFOSH standards written for specific operations.

3.10.3.4.5. Belts and lanyard assemblies must be visually inspected for defects prior to each use. The assembly must be inspected according to the manufacturer's recommendations at least twice annually. The date of each inspection must be recorded on an inspection tag that is permanently attached to the belt.

3.10.4. Identification of control procedures must be provided for hazardous conditions resulting from a spill or other mishap. Waste disposal procedures are also specified.

3.10.4.1. Rags, cotton waste, sawdust, excelsior, or other materials of a large surface area that have absorbed hydrazine or Monomethylhydrazine (MMH) may eventually cause spontaneous ignition. Such materials should not be stored under conditions that prevent dissipation of the heat that can accumulate by the gradual process of air oxidation.

3.10.4.2. Nitrogen tetroxide (N_2O_4) and mixed oxides of nitrogen are oxidizers, but they are not hypergolic with all combustible materials. Such non-hypergolic mixtures present an explosion hazard, particularly when subjected to elevated temperatures, pressures, or impact.

3.10.5. All operations involving the transfer or handling of N_2O_4 or hydrazines must be performed by groups of two or more persons with a thorough knowledge of the nature and properties of the materials.

3.10.6. Toxic Hazard Corridors (THC) forecasts provided for toxic propellant transfer operations are the basis for area access control. Input to the THC forecast by the user must consider the most credible spill quantity and expected wetted area of the incident.

3.10.7. An adequate water supply must be available for diluting, flushing, decontaminating, and firefighting when handling hazardous materials.

3.10.8. Suitable body-protective-clothing (acid and fuel-resistant, vinyl coated fiberglass protective suit) should be worn (AFM 161-30, Chemical Rocket/Propellant Hazards, volume II, appendix C). Polyethylene clothing may also be worn. Fiberglass clothing impregnated with acid-resisting plastics such as polytetrafluoroethylene (TFE) and polymonochlorotrifluoroethylene, is excellent for handling N_2O_4 and mixed oxides of nitrogen. Some types of rubber may burn when they come into contact with N_2O_4 or mixed oxides of nitrogen. The clothing must cover all parts of the body that may be exposed. It must be adjusted so it prevents leaks or spills from contaminating the body or draining into boots or gloves. An approved type of hood must be worn to protect the head.

3.11. Propellants and Propulsion Systems:

3.11.1. The design considerations contained in AFSC Design Handbook DH 1-6, TO 00-25-223, MIL-STD-1522, AFM 161-30; National Fire Prevention Association (NFPA) 70; and AFOSH standards are used in designing launch vehicle and spacecraft liquid propellant propulsion systems. All agencies using WSMC facilities must meet the following requirements:

3.11.1.1. Missile support systems piping and storage at launch pads or missile facilities must be identified according to MIL-STD-1247B.

3.11.1.2. Propellant lines and electrical lines must be located or designed to make sure that a single failure, such as leakage or electrical arcing, cannot cause ignition of the propellant.

3.11.1.3. A method must be provided for detanking propellants and decontaminating lines.

3.11.1.4. Ensure that GSE for loading dual propellant systems can be used independently and can be individually leak-checked.

3.11.2. All tanks, containers, and areas where toxics are handled must be separated with due regard for the minimum safe distance established by DOD regulations.

3.11.3. Storage, transfer, and areas where toxics are tested must be kept clean, free from combustibles, and frequently inspected.

3.11.4. There should be at least two access roads to transfer and storage sites of hazardous materials. Emergency egress personnel gates shall be installed and located on perimeter fencing to permit rapid evacuation of areas wherever toxic propellants are handled, transferred, or stored.

3.11.5. A written procedure with a checklist defined by the proper authority is required for operations involving filling of operational tankage.

3.11.6. The US Coast Guard is responsible for enforcing regulations concerning shipment of explosives and other dangerous materials via water, either all or part of the way. The regulations are contained in Coast Guard (USCG)-108.

3.11.7. Hazardous materials must be marked according to DOT classifications during shipment (for example, MMH is required to have a red label with a placard displaying "FLAMMABLE").

3.11.8. Test requirements are:

3.11.8.1. New, modified, relocated, or repaired propellant storage or transfer systems must be validated by a functional or proof pressure test prior to certification for operational use.

3.11.8.2. The user must certify in writing in the ARAR that system or subsystems have satisfactorily passed the required tests. The test data must be available for review.

3.12. Pressurized Systems:

3.12.1. Design requirements are:

3.12.1.1. Pressure system design considerations are contained in MIL-STD-1522, TO 00-25-223, MIL-P-5518, American Standard of Mechanical Engineers (ASME) Codes and AFSC DH 1-6. MIL-STD-1247B is used to identify lines on launch pads including GSE and flight equipment. MIL-STD-101B is used for systems other than missile launch systems.

3.12.1.2. A detailed system functional analysis must be performed to determine the operation, interaction, or sequencing of components will not lead to unsafe conditions, personnel injury, major damage to the spacecraft or RV, its booster, or associated ground support equipment.

3.12.1.2.1. System analysis data shows that the system provides the capability of maintaining all pressure levels in a safe condition in the event of interruption of any process, or control sequence, at any time during test or countdown.

3.12.1.2.2. A complete structural analysis must be accomplished for all pressure systems. The results of the structural analysis indicates safe stress levels for components and the structures required to support them.

3.12.1.3. During prelaunch pressurization, pressure monitoring must be provided by means of a hardline umbilical cable or telemetry.

3.12.1.4. Design via fracture mechanics is acceptable in lieu of conventional safety factors, but full records and analyses are required for review and approval by WSMC/SE on a case by case basis.

3.12.1.5. Personnel exclusion requirements for fracture mechanics-designed pressure systems is based on a "fail safe" basis (ductile vs brittle fracture mode).

3.12.2. Proof-pressure testing of modified or newly assembled systems is the same as for pressure vessel testing in MIL-STD-1522.

3.12.3. Ground support pressure vessels are designed according to MIL-STD-1522 or ASME.

3.12.3.1. Ground support equipment must provide for two sources of pressure relief; however, use of two burst discs is prohibited.

3.12.4. Aerospace vehicle equipment (AVE) pressure vessels will be designed according to MIL-STD-1522.

3.12.4.1. The 2:1 safety factor must not be violated in the pressure vessel by any combination of pressure and dynamically induced strain during on-base transport of pressurized AVE.

3.12.4.2. Unmanned launch vehicle pressure vessels which have a safety factor of less than 2:1 must be pressurized remotely. All personnel must be evacuated during pressurization and must stay evacuated as long as the vessel is pressurized. The only exception to this requirement is if a fracture mechanic's analysis is accomplished and the results show the pressurized vessel will leak before bursting. The analysis must be approved by WSMC Systems Safety Division (SES).

3.12.5. The data specified in MIL-STD-1522 will be supplied as an appendix to the ARAR, including complete schematics of the systems depicting pressurization and depressurization capabilities.

3.12.6. Where it is necessary to provide pneumatic pressure gauges for visual readout on pressurization systems, the requirements must be applied for safe design of pressure gauges specified in TO 00-25-223.

3.12.7. Design all pressure systems so that supply and operating pressures can be monitored by gauges or other suitable indicators (that is, remote monitors at control station).

3.13. Ordnance Systems:

3.13.1. This section establishes the policies and procedures to be met in design and operations such as handling, storing, installing, testing, and connecting ordnance during prelaunch operations at WSMC. Ordnance is defined as all electro-explosive devices (EED), detonators, squibs, primers, pyrotechnic devices, initiators, ignitors, solid propellants, explosives, warheads, ammunition, fuses, and energy transfer systems including, but not limited to, primacord, superzip, mild detonating fuse (MDF), and confined detonating fuse (CDF). Liquid propellants are also defined as ordnance by DOD for siting, storage, and handling purposes. In this document, liquid propellants are covered in paragraph 3.11.

3.13.1.1. Prior to first use of a procedure involving operations with live ordnance or pressure systems, practice operations should be conducted at VAFB using inert or dummy ordnance or nonpressurized systems. Certification as to the conduct of the dry run will be submitted with the ARAR.

3.13.2. Ordnance items must be assigned the appropriate DOD hazard classification according to DODS 5154-4, chapter 4. Items not previously classified must be tested according to TO 11A-1-47 (NAVORD Inst 8020.3) and classified accordingly. The user is responsible for classification tests and for submitting the results to WSMC/SE for concurrence. Preliminary DOD ordnance hazard classification data must be provided to WSMC/SES prior to arrival of the ordnance on the range. All ordnance initiating items will be classified as a Range category A or B device for both the preinstallation and

postinstallation situations. Category A EEDs are those that, by the expenditure of their own energy or because they initiate a chain of events, may cause injury (or death) to people or damage to property. Category B devices are those that will not, in themselves (hand-safe) or by initiating a chain of events, cause injury to people or damage to property (3.13.4 below for test requirements.)

3.13.3. Ordnance subsystems and their components will be designed according to MIL-STD-1576. Ordnance devices such as solid propellant rocket motors, destruct charges, and other ordnance systems will be designed so the sensitive or initiating elements can be installed in the system just prior to electrical hookup and as late in the countdown as possible or practical.

3.13.3.1. For fault tolerance general requirements, the design of an electro-explosive subsystem performing a safety critical function shall tolerate a minimum number of credible failures or operator errors according to the following criteria according to MIL-STD-1576.

3.13.3.1.1. If loss of ordnance function is safety critical, the design of the electro-explosive subsystem shall preclude single point failures and shall include at least two EEDs.

3.13.3.1.2. If inadvertent firing is safety critical, the design of the electro-explosive subsystem shall provide a condition such that no single failure or operator error can cause a critical hazard and no combination of two failures or operator errors can cause a catastrophic hazard.

3.13.3.2. Category A EEDs must meet the requirements of this paragraph to minimize the hazards of electromagnetic radiation to EEDs. Special considerations are given by WSMC/SE to any new EED concept or design that demonstrates adequate selectivity in response between direct current and radio frequency energy while maintaining reliability.

3.13.3.2.1. Category A ordnance circuits must be interruptible as close to the ordnance item as possible.

3.13.3.2.2. Category A ordnance devices must have one-amp and one-watt no-fire survivability.

3.13.3.2.2.1. The no-fire current must not be less than one ampere as the result of the application of a direct current (DC) voltage for five minutes, without the use of external shunts.

3.13.3.2.2.2. The no-fire power must not be less than one watt as the result of the application of a DC voltage for five minutes, without the use of external shunts.

3.13.3.2.3. The survivability levels of each EED, in its most sensitive mode, must be determined in terms of the RF power density that could produce the maximum-no-fire power in its bridgewire. In lieu of the one amp, one watt requirement, the WSMC user may validate the survivability of each electro-explosive device before, during, and after installation according to test method 4303 of MIL-STD-1576.

3.13.3.2.3.1. An EED firing circuit must not operate unintentionally when subjected to the RF radiation levels present at applicable WSMC locations. WSMC/SE can provide descriptions of the RF environment upon request.

3.13.3.2.3.2. In addition to validation of system survival, WSMC users must comply with requirements of 3.13.3.2.4 below, for firing circuits.

3.13.3.2.4. All category A firing circuits must be interrupted between the ordnance item and the power source by using an S&A device, arm/disarm device, barometric switch, arm or safe plug, or equivalent device that provides positive interruption of the circuit. These devices should be as close to the ordnance end of the circuit as possible. The devices must be capable of performing the inhibiting function when power is applied to the firing circuit. There is no mandatory range requirement for an ordnance system to contain a specific type of ordnance safing device in the ordnance circuit. The range requirement is for the following inhibit criteria to be met under all conditions. Three independent circuit inhibits are required for unlimited exposure of personnel during test. Two independent circuit inhibits will reduce exposure to essential personnel only and no exposure of personnel will be permitted if a circuit has only one inhibit. A range approved ordnance safing device that is manually pinned and safed can be counted as two (2) inhibits with pin in place.

3.13.3.2.4.1. Firing circuit leads and junctions must be shielded without electrical discontinuities or gaps to provide a minimum of 20 dB attenuation at all frequencies of the expected electromagnetic environment.

3.13.3.2.4.2. EED firing circuits, including EED leads, must be isolated from other electrical circuits and each other by means of individual shields at all times. Insulation resistance between all insulated parts, at a potential of 500 VDC minimum, must be greater than 2 megohms. Electromagnetic Interference (EMI) shielding between conductors must be 20 dB minimum. Shielded EED circuits may be routed together in a common secondary shield.

3.13.3.2.4.3. Firing circuit shields must be continuous from the power source to the EED cases. Splicing is prohibited. If the EED is enclosed in a metal container providing attenuation at least equal to that of the shield, the shield may be terminated at the container. Shields need not be carried through a connector if the connector can provide RF attenuation and electrical conductivity at least equal to that of the shield. Shields terminated at a connector must be electrically joined with no gaps around the full 360 degree circumference of the shield.

3.13.3.2.4.4. Firing circuit conductors, including EED leads, must be twisted and shielded to reduce induction from external alternating current (AC) and RF sources and maintain electrical balance in AC circuits.

3.13.3.2.4.5. If the power source is electrically isolated until after liftoff, shielding to the positive interruption rather than to the power source may be acceptable. Approval is dependent upon the RF characteristics of the positive interruption.

3.13.3.2.4.6. Demonstration of survival in the WSMC ground and aerospace vehicle environment must show that the EED cannot receive more than 20 dB below its maximum no-fire power in all modes of use and exposure. Computed RF power density levels for WSMC facilities are available from WSMC/SE.

3.13.3.3. A S&A device is a range approved, highly desirable, inhibit for category A firing circuits. S&A devices must satisfy the following requirements (exceptions for Exploding Bridgewire (EBW) systems are stated in 3.13.3.6 below).

3.13.3.3.1. When an S&A device is in the safe position, electrical shorts internal to the device must be maintained on the initiators and the explosive train will be interrupted by a mechanical barrier capable of containing the initiator's output energy.

3.13.3.3.2. When an S&A device is in the armed position, there is mechanical alignment of the explosive train and electrical continuity from the firing circuit connector to the initiator within the device.

3.13.3.3.3. S&A devices indicate armed or safe condition status by simple visual inspection.

3.13.3.3.4. For rotating devices, transitions from the safe to the armed position should require 90 degrees of rotation of the mechanical barrier. The device must not be capable of propagating an ordnance initiation with the barrier rotated less than 50 degrees, or movement of less than 50 percent for sliding barriers with the barrier in place.

3.13.3.3.5. The remote safe indication should not appear unless the device is within 10 degrees of the normal safe position for rotating systems or 10 percent of the total for sliding barriers. The remote armed indication should not appear unless the device is in a position that initiates the explosive train with the required reliability and confidence level.

3.13.3.3.6. The visual safe indicator should not be visible unless the device is within 10 degrees of the normal safe position.

3.13.3.3.7. A positive mechanical lock (safety pin) must be used in the device to prevent movement from the safe to the armed position. Rotation of more than 10 degrees must not be possible with the safety pin installed. Removal of the safety pin must not be possible if the arming circuit is energized. Removal of the safety pin will not cause the device to arm.

3.13.3.3.8. The control and monitor circuits must be completely independent of the firing circuits and use a separate and noninterchangeable electrical connector.

3.13.3.3.9. The device must provide a means of mechanical safing in the event of a malfunction or abort. During mechanical safing, the S&A must not cycle through the armed position.

3.13.3.4. Shielding caps must be provided and placed on the EED during shipment, storage, handling, and installation up to the point of electrical connection in the missile. The shielding cap will have an outer shell made of conductive material that provides an RF shield and makes electrical contact with the EED case. There will not be RF gaps around the full 360 degree mating surface between the shielding cap and the EED case.

3.13.3.4.1. The shielding cap must be designed to accommodate the torquing tool during installation or the torquing tool is designed to fit over the shielding cap.

3.13.3.5. Normally, percussion activated devices are initiated by the impact energy of a firing pin. This can be accomplished by "stab initiation," where the firing pin pierces the primer, or by percussion, where the firing pin does not puncture the case.

3.13.3.5.1. Only percussion initiators will be used and will meet the requirements of 3.13.3.2.4 above for category A ordnance circuits.

3.13.3.5.2. Each initiator must have a positive safety-interrupter feature that can be mechanically locked in place.

3.13.3.5.3. The initiator, and its interrupter, will be designed to withstand all transportation, handling, and installation environments.

3.13.3.5.4. The interrupter safety lock will be designed to remain in place during and after installation.

3.13.3.5.5. The interrupter safety lock will be designed to be removed after installation.

3.13.3.5.6. The interrupter will be designed to automatically disengage after launch as the result of on-board functions.

3.13.3.5.7. The design must make sure the device cannot be assembled without the interrupter.

3.13.3.5.8. Inadvertent firing pin activation requires at least two independent faults in addition to the mechanical safety lock.

3.13.3.6. EBW system initiators, by their nature, require high current for firing and are considered to meet the requirements of 3.13.3.2.2 above. However, EBW systems must:

3.13.3.6.1. Include a dual bleed system with either system capable of bleeding the capacitor charge.

3.13.3.6.2. Have remote monitoring of the capacitor charge status.

3.13.3.6.3. Include a voltage blocking gap that breaks down at voltages consistent with reliable initiation. The voltage blocking gap should break down within 10-45 milliseconds at approximately 1800 ± 300 volts when subjected to a peak voltage of not less than 2200 volts across a load of not less than 90 megohms.

3.13.3.6.4. Have a gap that breaks down when subjected to a high voltage pulse of short enough duration to provide ample amperage into the bridgewire to cause the EBW to explode with sufficient energy to reliably transmit the reaction to the prime charge.

3.13.3.6.5. Contain explosive materials of an insensitive mixture such as pentaerythritol tetranitrate (PETN) and research department explosive (RDX).

3.13.3.6.6. Have insulation resistance between the terminal(s) and any device and must not be less than 2 megohms at 500 volts DC.

3.13.3.6.7. Have a device that does not fire or degrade when subjected to 25,000 volts from a 500 pfd capacitor.

3.13.3.6.8. Have a device that does not fire or degrade when subjected to a voltage of 125 to 130 volts roots mean square (Vrms) at 60 Hertz (Hz) applied between the terminals or the terminals and the device body for 5 minutes ± 10 seconds.

3.13.3.6.9. Have a device that does not fire or degrade when subjected to a source of 500-520 volts having an output capacitance of 1.0 ± .10 microfarads applied across the terminals or the terminals and device body for 1.0 to 1.5 minutes.

3.13.3.6.10. Have a device that does not fire or degrade so it is unsafe to handle when 230 ± 10 volts Vrms at 60 Hz are applied between the terminals and the terminal and device body for 5 minutes ± 10 seconds.

3.13.3.6.11. Have a unit that does not fire or degrade after exposure to that level of power equivalent to absorption by the test item of 1.0 watt average power at any frequency within each range of RF energy, as specified in table 3-1. The power is applied across the input terminals of the EBW detonator for 5.0 to 6.0 seconds.

	Frequency in Megahertz	Modulation*
1	1.5	Continuous Wave
2	27.0	Continuous Wave
3	154.0	Continuous Wave
4	250.0	Continuous Wave
5	900.0	Continuous Wave
6	2700.0	Pulsed Wave
7	5400.0	Pulsed Wave
8	8900.0	Pulsed Wave
9	15000.0	Continuous Wave
10	32000.0	Pulsed Wave

*Pulsed wave has a modulation with pulse width of 1 microsecond and pulse repetition rate of 1 KHz.

Table 3-1. RF Sensitivity.

3.13.3.6.12. Maintain auto-ignition temperature of the device above 300F.

3.13.3.7. Category B EEDs are not required to comply with the RF and stray voltage or no voltage requirements of this chapter. RF protection for category B EEDs is the sole responsibility of the WSMC user. RF silence is not scheduled to protect category B EEDs.

3.13.3.8. Ordnance circuits shall be capable of being manually safed during any phase of ground operation.

3.13.3.9. This paragraph establishes the policies for the user to accomplish the selection, and identify the usage, of plastic film materials in conjunction with payloads and missile systems at VAFB.

3.13.3.9.1. A written safety analysis shall be prepared by the user and submitted to WSMC/SE for approval and shall include, but not be limited to:

3.13.3.9.1.1. Identification and characteristics of the plastic film to be utilized.

3.13.3.9.1.2. The method or conditions under which the materials are to be utilized .

3.13.3.9.1.3. An assessment of the hazards involved and the method or action to be taken to minimize any related risk.

3.13.3.9.2. Hazard control measures will include:

3.13.3.9.2.1. Identification of the bleed-off capability of the "as-used" configuration.

3.13.3.9.2.2. Identification of the method to be utilized to assure continuing anti-static properties of the selected material or method.

3,13.3.9.2.3. Identification of the cleaning methods to be used to maintain surface cleanliness.

3.13.3.9.2.4. Establishment of minimum acceptable voltage accumulation levels for the materials or operations.

3.13.3.9.2.5. Establishment of a method for assuring continuity between adjoining pieces of the plastic film materials.

3.13.3.9.2.6. Identification of flammable or explosive materials and methods for monitoring for the presence or status of these materials.

3.13.3.9.2.7. Identification of the energy source required to cause ignition of flammable or explosive mixtures and the methods to preclude this ignition.

3.13.3.9.2.8. Identification of clothing and equipment restrictions for personnel performing the identified operations.

3.13.3.9.2.9. Assessment of the environmental effects on the selected material; such as humidity, ultra-violet light, temperature.

3.13.3.9.3. The user shall provide the above information to WSMC/SE for review and approval at least 120 days prior to the first planned use of the selected materials or operations at VAFB.

3.13.3.9.4. The user shall notify WSMC/SE of all proposed changes to the above information prior to performing operations utilizing those changes.

3.13.3.9.5. Prior to proceeding with usage of the materials at VAFB, approval must be received from WSMC/SE.

3.13.3.9.6. Spacecraft and launch operations at VAFB will not be conducted in relative humidities below 45% without specific approval from WSMC/SE.

3.13.3.9.7. Additional information concerning guidance for selection of plastic film at VAFB may be obtained by contacting WSMC/SES.

3.13.4. Test requirements are:

3.13.4.1. Operations having an electrical potential applied to an ordnance item will be considered as electrical testing of ordnance. All electrical testing of category A ordnance will be considered as hazardous until the range user submits an analysis to WSMC/SES which proves otherwise. Electrical testing of any ordnance item that could result in injury or death to personnel (if the item should fire) must be conducted remotely (for example, in a test cell or behind a barricade or shield). All test equipment used to check out ordnance and ordnance circuits must be approved by WSMC/SES prior to use on the range.

3.13.4.2. For special ordnance tests, such as in nonapproved test locations or test cells, a justification of why the test has to be performed in location described and time sequence must be provided. It must include the data below, plus a description of what alternatives were considered and rationale for the decision:

3.13.4.2.1. All procedures and ordnance circuit schematics relating to electrical testing of ordnance.

3.13.4.2.2. Precautions to prevent injury to personnel or damage to equipment.

3.13.4.2.3. A description of the location and configuration of the test.

3.13.4.2.4. A description of worst case event as a result of initiation of each device being tested.

3.13.5. The user submits copies of the information in the format shown on WSMC Form 87, Validation of Compliance, and WSMC Form 96, Ordnance Technical Data, as an appendix to the ARAR. Where identical ordnance items or S&A devices have been approved and utilized on other programs at WSMC, the user need only reference the ordnance item or S&A devices

and the approval date and authority in lieu of submitting WSMC Forms 87 and 96.

3.13.6. EMI testing will not be conducted with category A EEDS installed on the vehicle or payload without written approval by WSMC/SE.

3.13.7. The WSMC user is responsible for making no voltage or stray voltage checks on circuitry connecting to category A ordnance prior to the connection or prior to test equipment and support equipment connections to such circuits. A no voltage check, for example, would be made when mating two missile stages and one of the stages contains an AVE battery or other voltage source. The test would be made looking for no voltage toward the voltage source prior to making the final connection. A stray voltage check, for example, would be made prior to connecting ground test equipment to a single stage for electrical testing. Stray voltage tests should be made with equipment in a POWER ON condition and then in a POWER OFF condition. This sequence is to assure there are no sneak circuits in the cable or equipment which may allow voltage to exist on the ordnance circuits. In instances where some voltage is permitted, it must be specified in the test procedure and approved by WSMC/SE. These tests are not necessary in category B ordnance circuits and may not be required on category A circuits depending upon the number of inhibits in place at the time of final cable connection. It is the responsibility of the WSMC user to obtain a deviation from WSMC/SE when such tests are not accomplished on category A circuits.

3.13.8. The range user is responsible for ensuring that render safe procedures and normal safing procedures are available for their systems.

3.13.8.1. Render safe procedures must be available prior to arrival of the range users' first live ordnance at Vandenberg. Normal safing procedures must be available to support launch countdown operations (i.e. hangfire, misfire, no fire).

3.13.8.2. Normal safing, as used in this regulation, applies to the act of returning ordnance systems to a safe configuration. It differs from render safe functions in that ordnance system status or control is not lost. For example: A missile hangfire, misfire, or no fire where ordnance systems can be remotely returned to a safe condition and system status is not lost, will be accomplished with a normal safing procedure. A hangfire, misfire, or no fire with loss of ordnance status or loss of ordnance system control where safety of the safing crew cannot be guaranteed, will normally be considered a render safe function for returning the system to a safe condition. Render safe procedures performed by EOD and/or contractor support personnel would be used for that situation. The range user must clearly identify in the MSGSA submittal, specific tasks his support contractors will or will not perform during render safe operations. WSMC/SE recognizes that written procedures cannot be prepared in advance to address all possible variations of render safe tasks. However, the range user must consider as many different render safing tasks as feasible and must have a normal safing procedure to recover from a missile hangfire, misfire, or no fire situation.

3.13.8.3. All render safe and normal safing tasks will be considered hazardous until ordnance systems are returned to a known safe condition. WSMC/SES will approve them prior to use.

3.13.8.4. Render safe procedures and adequate EOD or contractor support personnel training with those procedures are mandatory prior to issuing MSGSA by WSMC/SES. The range user must plan, program, and fund for render safe procedure preparation as well as EOD or contractor support personnel training for render safe operations as required.

3.14. Electrical and Electronic Systems:

3.14.1. Electrical and electronic systems must meet design requirements of AFSC DH 1-6, section 4E.

3.14.1.1. Elements of safety-critical redundant systems may not pass through the same connector used by elements of the primary system.

3.14.1.2. System design limits the use of connectors to applications that require frequent disconnection, such as for rapid component replacement. Hardline wiring is the preferred means of connection.

3.14.2. Hazardous atmosphere areas are those locations where possible explosive concentrations (dust, vapor, or gas) may exist and, therefore, require explosion-proof or hazard-proof equipment. Hazardous areas are defined in the National Fire Protection Association (NFPA) codes and standards.

3.14.2.1. Electrical and electronic systems located in hazardous atmosphere areas must be certified to WSMC/SE showing compliance with the requirements of the NEC, NFPA 70.

3.14.2.2. Electrical and electronic equipment must be "explosion-proof" per article 500, NEC, or hazard proofed (by potting, hermetically sealing, or by positive pressurization with an inert gas). Where large enclosed rooms of equipment are located in the hazardous atmosphere area, it is acceptable to pressurize these rooms to at least 1/10 inch of water with clean air or inert gas taken from outside the area, preferably from two remote sources. No propellants will be kept in these rooms. An alternate acceptable method is to install leak detectors in the hazardous atmosphere area with a single monitoring station. A master switch at the monitoring station must be capable of deactivating all nonexplosion-proof or nonhazard-proof equipment in the area; this station must be manned at all times when a hazardous atmosphere may exist, or automatically deactivate the nonexplosion-proof equipment when 25 percent of the lower explosive limit of hazardous atmosphere is reached. Before "hot work" is performed, it must be verified that hazardous atmosphere concentrations are less than four percent of the lower explosive limit.

3.14.2.3. Electrical and electronic equipment within 100 feet of a missile must meet the hazardous atmosphere requirements of the NEC, article 500.

3.14.3. Electrical and electronic design of safety critical AVE requirements are as follows:

3.14.3.1. Connectors must be keyed, sized, or configured so it is physically impossible to interconnect incompatible systems. Where cross-connection has no impact on system operation or performance, connectors may be identical. However, a statement to this effect is required as part of the data submittal.

3.14.3.2. Airborne batteries will be provided with current limiting devices or equivalent protection on their output and input lines. Temperature sensitive devices monitor battery temperature and disconnect the battery in the event of overheating.

3.14.4. Electronic design of all GSE will incorporate a main power switch located on the equipment. If fault isolation switches are incorporated in the design, they may not apply power independently of the main power switch.

3.14.4.1. The equipment must be constructed and designed so external parts, surfaces, and shield are at GSE ground potential at all times.

3.14.4.2. Power switches must be located and guarded so accidental contact by personnel does not place equipment in operation. Critical switches that can produce or induce hazardous conditions if inadvertently activated must have a protective cover over them.

3.14.4.3. Maximum depth of discharge of ground support batteries should not exceed 75 percent.

3.14.4.4. Electrical fuse and switch boxes must be stenciled on the outside to show the voltage present and the functions controlled by the circuits.

3.14.5. Batteries must be capable of easy disconnection and removal.

3.14.5.1. Polarity of terminals must be marked.

3.14.5.2. Connections must be designed to prevent reverse polarity.

3.14.5.3. Sufficient ventilation must be provided.

3.14.5.4. Battery charging current must be limited by design. It must be impossible to initiate or sustain a runaway failure of a battery because of the charging current.

3.14.5.5. Batteries will be sealed and must have pressure relief valves or blowout plugs. Vented batteries must vent gases to an area where ignition of gas is impossible. Recombination cells must be used whenever possible.

3.14.5.6. Cell and case retention must be provided to the maximum extent possible to minimize the hazard of battery rupture. Proper ventilation as described in 3.14.5.5 above must still be maintained.

3.14.5.7. Lithium base batteries must be stored in a cool, well-vented area remote from all other batteries.

3.14.5.8. Lithium batteries require hazardous procedures for all operations to include storage and disposal.

3.14.6. Mechanical or electro-mechanical devices used for structure deployment or actuating release mechanisms are evaluated to establish if damage to equipment or injury to personnel could occur in the event of inadvertent initiation. If it is determined that damage to equipment or personnel injury could result, the device, or devices, must be controlled in a manner similar to category A ordnance devices. At least two independent actions must be taken in a serial sequence prior to activation of the device.

3.14.7. Grounding, bonding, and shielding requirements are:

3.14.7.1. Missile ordnance items and related handling equipment must remain grounded during receipt to launch processing tasks. This is particularly true of missile stages with EEDs installed and especially true during stage lifting operations with cranes. Many different methods of grounding exist and the particular method chosen is left to the discretion of the range user. The main guideline to be followed is that the ordnance item and anything conductive which interfaces with it must be kept at the same voltage potential. The range recognizes that ordnance cannot be kept grounded at all times, for example, transportation, but the range user must describe his grounding methods and exceptions, with analysis, in the ordnance section of the ARAR.

3.14.7.2. Solder connections must not be used on ground circuit connections.

3.14.8. Users are responsible for verifying that requirements of this section have been met. The adequacy of grounding and interlock mechanisms are of particular concern. These items must be reverified before operations at WSMC.

3.14.8.1. The discharge (to 30 volts or less) time is required for all capacitors that are charged to 30 volts or more.

3.14.8.2. Users who design, build, or modify intrinsically safe apparatus for use in class I, II and III, division 1 hazardous locations must submit all test results required by NFPA 493 to WSMC/SES.

3.14.9. The user submits copies of the information in paragraph 3.14.8 above for all electrical and electronic systems as an appendix to the ARAR.

3.15. Software and User-System Interface (USI):

3.15.1. Software requirements shall be addressed during the earliest stages of system development and shall be worked in parallel and concurrently with hardware requirements.

3.15.2. All computer software (including that associated with embedded computers and computer systems or associated with automated test equipment) used to control or monitor safety critical ground or flight sequences, functions or processes shall be designed according to attachment 3, as tailored by WSMC/SE in conjunction with the procuring agency. In addition, Weapon System software development shall be accomplished according to MIL-STD-1679 and trainer system software shall be accomplished according to MIL-STD-1644.

3.15.3. The software system shall meet the requirements of MIL-STD-1574.

3.15.4. The system software shall possess the following general properties characteristic of high quality software: correctness, reliability, validity, resilience, useability, clarity, maintainability, modifiability, generality, testability, efficiency and economy.

3.15.5. Procedures, rules, and constraints shall be used for program design, program structure and data structure which enhance the readability, controlability, testability, extendability, reliability and maintainability of programs and which minimize rework during the programming process.

3.15.6. The software structure shall be standard and allow for additions, deletions, and modifications of software modules to accommodate requirement changes with minimal impact to the software.

3.15.7. The software system design shall be compatible with the hardware system design.

3.15.8. The software system shall be capable of fully utilizing the hardware system capability.

3.15.9. The software system shall be designed to not overstress the hardware system.

3.15.10. The software system shall be capable of recognizing hardware system failure modes.

3.15.11. The software system shall have the capability to detect and isolate computer system failures and provide standby or alternate paths to permit safing of critical functions.

3.15.12. The software system shall have the capability to detect safety critical malfunctions. It is desirable for software to determine the source and effect of such malfunctions, evaluate the effect on the system and any consequent effect on the mission, determine the corrective action to be taken, implement said corrective action when and where appropriate, and retest the system after corrective action has been completed.

3.15.13. Computer programs and equipment interfaces shall provide a functional interface between the elements of the system, including the system operators, maintainers and the computers (see MIL-STD-1472C, para. 5.15, Personnel-Computer Interface). This interface shall optimize compatibility with personnel and minimize any other factors which degrade human performance or contribute to human errors.

3.15.14. Software products shall be fully documented and a configuration management and control program shall be implemented to insure integrity and accountability of all operational software products (MIL-STD-480, -483, and -490).

3.15.15. All operator initiated commands which perform safety critical sequences or functions (such as propellant flow and launch initiation) shall, as a minimum, be written as two step 'ARM' and 'EXECUTE' commands.

3.15.16. The user shall provide the following information to WSMC/SE:

3.15.16.1. Hardware description including layout of operator consoles and displays.

3.15.16.2. Flow charts or diagrams showing hardware, data busses, hardware or software interfaces, data flow, and power systems. Show redundant systems.

3.15.16.3. Logic flow chart.

3.15.16.4. Operator user manuals and documentation.

3.15.16.5. List with description of all critical software modules including interfaces.

3.15.16.6. Software hazard analysis (SHA).

3.15.16.7. Configuration management plan and procedures.

3.15.16.8. Software test plan, test procedures and test results.

3.15.16.9. Copies of any Soft Tree, Sneak Circuit, Petri Net, NSCCA or other hazard analyses accomplished on the hardware or software. Such analyses should address the hardware and software interfaces.

Chapter 4

FLIGHT TERMINATION AND TRACKING TRANSPONDER SYSTEMS

4.1. Flight Termination and Tracking Transponder Systems Introduction. Paragraphs 1.8 and 1.9.1 require that all missiles and space vehicles flown from the WTR be equipped with a flight termination system and a tracking transponder system. This chapter sets forth the design, operation, testing, and data requirements, and prescribes the procedures for approval and use of those systems at WSMC.

4.2. Approval Requirements:

4.2.1. WSMC Flight Termination Division (SEO) participation during the flight termination system development phase reduces costly engineering changes at a later date and facilitates timely system approval; therefore, contact should be established with WSMC/SEO as early in the development phase as possible. WSMC/SEO shall be notified of, and represented at, TI, SDR, PDR, and CDR meetings. Information, including meeting purpose(s) and agenda items, with as many amplifying details as possible, shall be provided to WSMC/SEO as early as possible but in no case less than 10 days prior to the meeting. This provides time for preliminary evaluation of the agenda items and enables the WSMC/SEO Range Missile Control Representative (RMCR) to identify problem areas, negotiate acceptable changes, and provide interim approval(s) at the meeting. Further, if adequate information is provided prior to the meeting, the RMCR may recommend waiver of specific requirements of this chapter. Each recommended waiver must be fully documented in the meeting minutes and the minutes must be signed by the RMCR. However, prior to formal acceptance of the system, a formal waiver action (paragraph 1.7) must be accomplished. Formal acceptance of the system for use at WSMC is granted by WSMC/SEO approval of the flight termination report (paragraph 4.7.1.6). Two copies of the report must be submitted to WSMC/SEO at least four months prior to the first scheduled launch. Ideally, an acceptable system and component design have been achieved, qualification tests sucessfully completed, and receipt through launch procedures agreed on prior to submission of the flight termination system report. However, if unacceptable conditions or open items still exist, they must be formally resolved so approval can be granted at least 30 days prior to the first scheduled launch.

4.2.2. The detailed test plan(s) and procedure(s) for accepting and qualifying the flight termination system must be approved by WSMC/SEO prior to testing. This should be accomplished during the applicable technical interchange or design review. Also, at this time, the WSMC/SEO representative will identify the individual qualification and acceptance test plan(s) and procedure(s) required to be submitted to WSMC/SEO for approval.

NOTE: The terms Acceptance Test and Qualification Test are defined in MIL-STD 1540A.

4.2.3. Detailed procedures for test, calibration, and installation of all components of the flight termination system and associated ground checkout equipment, including the launch day countdown procedures, must be submitted to WSMC/SEO and approved before launch approval is granted. Once these procedures are approved by WSMC/SEO, they cannot be changed without prior approval.

4.2.4. Flight termination systems or components that fail due to damage, unreliability, failure to meet manufacturer and model specifications, or limits of this regulation, cannot be approved for flight until corrective action, acceptable to WSMC/SEO, has been made to all components or systems subject to such failure modes.

4.2.5. Modification or change to an approved airborne flight termination system, associated equipment, components, component identification, test procedures, performance test limits, basic characteristics, ratings, or any changes affecting the integrity of

the flight termination system, cannot be made without prior WSMC/SEO approval. Modification proposals must be submitted with sufficient lead time (at least 60 days) for evaluation to avoid delay of launch schedule. The proposal must include all data information applicable to the modification that is required in the approval of a new system. It is conceivable that unique situations will arise requiring expedient minor changes to the flight termination system, its associated ground support equipment, or to the system testing procedure to permit timely accomplishment of a particular launch operation. In this instance, WSMC/SEO should be notified immediately and maximum effort will be expended to conduct a rapid evaluation of the proposed changes. Assistance will be provided to achieve a change that resolves problem areas and will be acceptable to WSMC. If any modification to an approved system has been made without prior approval of WSMC/SEO, the approval of the entire system and the approval to launch is automatically revoked until the change is approved.

4.2.6. Final acceptance of the flight termination system for each launch depends on the satisfactory completion of all required prelaunch tests and system installation functions.

4.2.7. WSMC/SEO approves all flight termination component and system qualification, acceptance, flight readiness, and operational testing. Certification includes review and approval of test procedures and system test setups, and witnessing of testing at each vendor, associate contractor, and prime contractor facility. The Range user notifies WSMC/SEO of the date, time, location, and point of contact for all flight termination testing at least ten days prior to the test. WSMC/SEO will then provide notification of whether the test will, or will not, be witnessed.

4.3. Design Requirements:

4.3.1. The flight termination system must be designed to receive frequency modulated radio messages and resultantly terminate flight of the missile or space vehicle. For this purpose, the Interdepartment Radio Advisory Committee (IRAC) has authorized a WSMC frequency assignment of 406.5 MHz and 416.5 MHz, 360 KHz bandwidth, F9 emission at 10 KW power. Frequency protection is provided by IRAC so no frequency assignment in the 360 KHz bandwidth will be made to any other agency within 50 miles of the VAFB missile launch sites. Therefore, Range user transmitters at test stations are not allowed to radiate on the WSMC frequency assignment. Closed loop transmission by Range user transmitters, or test stations for flight termination system testing, is permissible according to WSMCR 100-1, Radio Frequency Management. A typical flight termination system consists of an antenna system, receiver and decoders, electrical power sources, controls, relays, non-destructive flight terminating devices, S&A devices, destructive ordnance systems, and interconnecting circuitry. While system design simplicity and minimum component usage is a desired goal, the system must contain the redundancy necessary to meet the requirements of 4.3.1.10.1 below. The required receiver and decoder message outputs are specifed in 4.3.3.3.12 below, and the resultant flight termination actions correlated to the vehicle propellant compositions are specified in 4.3.1.3.1 through 4.3.1.3.6 below. Ideally, each powered stage of the vehicle should contain an internally installed radio command link consisting of the antenna systems, receivers, decoders, and electrical power sources. However, considerations such as the added weight, cost, launch vehicle design, and mission objectives normally preclude that configuration concept. As an alternative, a radio command link, protected by an automatic flight termination activating system specified in 4.3.1.2.5, 4.3.1.2.8, and 4.3.1.4 below, is acceptable.

4.3.1.1. All components of the flight termination system and methods of attaching or installing the system must be designed and qualified to make sure the system has the ability to function reliably under environmental forces greater than those that would result in breakup of the missile while it is within the limits of WSMC safety

responsibility. All components of the system must also be designed to withstand, without degradation in performance, the environment it is subjected to during storage, prelaunch processing, checkout, and launch. Ample consideration must also be given to the corrosive environment caused by launch vehicle propellants, humidity, dust, and salt atmosphere at WSMC. If the system is subjected to the shock and heat of an igniting engine or staging events, it must also be designed to sdrvive that environment. Particular emphasis must be placed on the ability of an automatic system to withstand forces greater than those that would lead to destruction of the missile stage joint that it is protecting.

4.3.1.2. Radio command link location requirements are:

4.3.1.2.1. When the radio command link is installed above the last powered stage, an automatic activating system must be provided immediately to activate the flight terminating devices on each powered stage if the radio command link container should break away or should inadvertently separate from the vehicle.

4.3.1.2.2. For single stage powered vehicles, the command system must be installed in the stage with flight termination control system actuating devices capable of accomplishing the action required by 4.3.1.3 below when actuated by the command system.

4.3.1.2.3. For multi-stage powered vehicles not scheduled for orbital insertion, a radio command link must be installed in or above the last (uppermost) powered stage of the vehicle. All powered stages must contain flight termination devices capable of accomplishing the action required by 4.3.1.3 below.

4.3.1.2.4. For multi-stage powered vehicles scheduled for orbital insertion, the orbital stage(s) will be injected into orbit prior to its (their) ignition, a command system is not required on this (these) orbital stage(s). A command system must be installed on the powered stage that actually injects the vehicle into initial orbit. All stages, including injected powered stages, must contain flight termination actuating devices capable of accomplishing action required by 4.3.1.3 below when actuated by the command system.

4.3.1.2.5. For all multi-stage powered vehicles, an automatic flight termination system that meets the requirements of 4.3.1.4 below must be installed on each powered stage, including orbital stages not containing a command system.

4.3.1.2.6. Cruise or glide vehicles shall contain either a command system according to 4.3.1 above, or a combination of a command system and a "fail safe" system that is activated upon loss of the radio command carrier. If the command system is dependent upon a single power supply, a low voltage "fail safe" capability must also be provided to actuate flight termination action if the command system primary voltage supply drops below the minimum voltage required for operation of the command system.

4.3.1.2.7. Vehicles that are a combination of ballistic and cruise or glide vehicles are treated as a ballistic vehicle during the boost phase, and a cruise or glide vehicle thereafter.

4.3.1.2.8. Propulsion systems or other hazardous systems that are not considered a stage of the vehicle may require flight termination control systems capable of accomplishing the action required by 4.3.1.3 below when actuated by an automatic or command system. This capability is required for all solid motor thrust augmenting rockets. In the case of propulsion systems, such as ullage rockets, retro and escape rockets, this capability is required only if they present radiological, toxicological, explosive, or other significant hazards. In both instances where command capability is required, an automatic system that meets the requirements of 4.3.1.4 below will also be required if the propulsion system(s) has the capability of reaching the impact limit lines in the event of premature separation.

4.3.1.2.9. Flight termination systems on manned vehicles must meet the following requirements:

4.3.1.2.9.1. Manned vehicle flight termination control systems must comply with all requirements of this regulation, with the exception that the manned portion of the vehicle may not require destruct capability on manned flights. If manned vehicles are flown unmanned, all requirements of this regulation must be met.

4.3.1.2.9.2. Time delays between ARM (engine shutdown) and destruct action, required for crew escape, are provided by WSMC in the ground equipment. The extent of these delays is determined by vehicle parameters, the type of escape system, and the degree of hazard presented.

4.3.1.3. Flight termination action requirements are:

4.3.1.3.1. For vehicles consisting of all liquid propellant stages, both ARM and destruct capability are required for each stage of the vehicle (except as noted in 4.3.1.3.4 below). The transmitted "Arm" command must be utilized as a predestruct logic function within the command system receiver and decoder. It must cause nondestruct engine shutdown of the thrusting stage(s) and inhibit ignition of all other stages. The subsequent transmitted "destruct" command, or activation of the automatic flight termination system, must cause the following:

4.3.1.3.1.1. For liquid propellent stages using toxic propellants, the destruct charges must cause penetration of the propellant tanks and initiate rapid burning of the propellants so that as much propellant as possible is consumed or dispersed. For toxic hypergolic propellants, the requirement for initiation of burning is deleted since the propellants burn on contact. The intent of this requirement is to consume or disperse the maximum amount of propellant at altitude. This reduces the impact area toxic hazard and the hazard caused by hypergolic bipropellant combinations, such as nitrogen tetroxide and aerozine-50, that may detonate with high yields upon high velocity impact with the ground.

4.3.1.3.1.2. For liquid propellant stages using nontoxic propellants, the destruct charges must cause penetration of the propellant tanks, both fuel and oxidizer, to the extent necessary for rapid dispersion of the propellants. The intent of this requirement is to make sure that the maximum amount of propellant is dispersed before vehicle impact with the ground. This reduces the impact area hazard by reducing the explosive yield.

4.3.1.3.2. For vehicles consisting of all solid propellant stages, the transmitted "Arm" command must be utilized only as a predestruct logic function within command system receiver and decoder. The subsequent transmitted destruct command, or activation of the automatic flight termination system, must cause the following:

4.3.1.3.2.1. For solid propellant motors with propellant grain dimensions greater than 80 percent of the critical diameter and geometry of the propellant formulation used, the destruct charge should ignite any nonburning grain and should destroy the pressure integrity of the motor. This action must cause either a condition of zero thrust, or any residual thrust must cause tumbling so that no significant lateral or longitudinal deviation of the impact point could result. Further, for propellant formulations where detonation in the uprange area could result in a hazardous overpressure condition, the destruct charge should be designed to break up, but not detonate, the propellant grain.

4.3.1.3.2.2. For solid propellant motors, with propellant grain dimensions that are 80 percent or less of the critical diameter or geometry of the propellant formulation used, and do not present a detonation overpressure condition, the destruct charge need only

destroy the pressure integrity of the motor. This action must cause either a condition of zero thrust or any residual thrust must cause tumbling so that no significant lateral or longitudinal deviation of the impact could result.

4.3.1.3.3. For vehicles using a combination of liquid and solid propellant stages, the requirements of 4.3.1.3.1 and 4.3.1.3.2 above apply. In addition, nondestructive thrust termination may be necessary for the solid propellant stages. The need for that capability will be determined by the:

4.3.1.3.3.1. Missile launch trajectory.

4.3.1.3.3.2. Liquid and solid propellant stage stacking sequence.

4.3.1.3.3.3. Liquid and solid propellant stage thrusting sequence.

NOTE: Destruct action of one stage may cause undesirable reactions in another stage; therefore, detailed information relative to the above areas should be provided to WSMC/SEO as early in the system design period as possible for review and resolution.

4.3.1.3.4. Propulsive systems on other than stages of the vehicles are:

4.3.1.3.4.1. Combination solid propellant thrust augmentation with solid propellant vehicles. For solid propellant thrust augmenting rockets used with solid propellant vehicles, the requirements of 4.3.1.3.2.1 or 4.3.1.3.2.2 above apply, as appropriate.

4.3.1.3.4.2. Combination solid propellant thrust augmentation with liquid propellant vehicles. For solid propellant thrust augmenting rockets used with liquid propellant vehicles, the transmitted "Arm" command must cause nondestructive thrust termination of all thrust augmenting rockets. If the thrust augmenting rocket(s) fall within the size described in 4.3.1.3.2.2 above, the activation of the automatic flight termination system (if required) must cause the same action as the transmitted "Arm" command and no further action is required by the transmitted destruct command on these thrust augmenting rockets. If the thrust augmenting rockets fall within the size described in 4.3.1.3.2.1 above, the transmitted destruct command or activation of the automatic flight termination system (if required) must cause the action described in 4.3.1.3.2.1 above on the thrust augmenting rockets.

4.3.1.3.5. For all other auxiliary propulsive systems, no action to the system is required by the transmitted "Arm" command. The transmitted destruct command, or the activation of automatic flight termination system (if required), must cause the same action as required for stages of the vehicle having the same type fuel.

4.3.1.3.6. For cruise or glide vehicles, flight termination action must cause a condition of zero lift (for example, separation of wings, control surfaces, empennage, or complete disintegration) and must disperse all propellants carried on board.

4.3.1.4. Automatic flight termination systems must be designed to be activated by:

4.3.1.4.1. Vehicle breakup or premature separation of any powered stage interface above or below the powered stage(s) containing the command system.

4.3.1.4.2. Inadvertent separation of the command system stage if located above the last (uppermost) powered stage of the vehicle.

4.3.1.4.3. Premature separation of any auxiliary propulsion system requiring an automatic flight termination system under 4.3.1.2.7 above. Activation of the automatic flight termination system on a stage or other propulsion system must result in the

appropriate flight termination action required by 4.3.1.3 above. This precludes the possibility of any stage or designated auxiliary propulsive system being capable of powered flight without a method of flight termination. Any method that reliably activates the system upon inadvertent separation of the protected interfaces (for example: lanyard, microswitch, break wires, or similar device) is acceptable. Each stage or auxiliary propulsive system requiring an automatic flight termination system that is electrically initiated must contain a dedicated power supply or a firing capacitor bank to supply the energy required to initiate the flight termination actuating devices. The flight termination system actuating devices activated by the automatic flight termination system may be common with the command system devices. Particular emphasis must be placed on the ability of the automatic flight termination system to withstand forces greater than those that would lead to destruction of the missile stage interface it is protecting. In cases where the system could be subjected to the shock and heat of a prematurely separating or igniting upper stage, the system must be designed to survive that environment and operate with the required reliability.

4.3.1.5. Flight termination circuitry design requirements are:

4.3.1.5.1. Flight termination circuitry must be shielded, filtered, grounded, or otherwise isolated to preclude the electromagnetic environment that it is operated in from responding to or causing interference that would inhibit and degrade the function of the system, cause an undesired output from the flight termination system, or interfere with other systems in the vehicle that could result in a hazardous situation.

4.3.1.5.2. All flight termination systems and missile system interface components containing reactive elements (for example: relays, electrical motors, or similar devices) that are capable of producing transient voltages, must be provided with suppression circuitry to prevent interference or damage to flight termination control system components and other vehicle subsystems.

4.3.1.5.3. System design must be such that the destruct action of any stage will not sever or damage interconnecting flight termination system electrical, mechanical, ordnance, or other coupling equipment to other stages until destruct action is reliably initiated on the other associated stages.

4.3.1.5.4. The performance of the flight termination system (except for the affected monitor circuit) shall not be affected by external shorting of a monitor circuit or the application of any positive or negative voltage between 0 and 35 volts to any flight termination monitor circuit.

4.3.1.6. Prelaunch testing design requirements are:

4.3.1.6.1. All circuitry, elements, components, and subsystems of the system must be capable of withstanding, without degradation, repetitive functioning and applications of electrical energy and mechanical forces incurred during prelaunch testing.

4.3.1.6.2. Flight termination and missile system design shall provide the capability to perform the following receipt-through-launch testing:

4.3.1.6.2.1. Testing under 4.5.2.1.1 below for vehicles operating under the "Factory-To-Pad" concept.

4.3.1.6.2.2. Testing under 4.5.2.1.2 below for vehicles not operating under the "Factory-To-Pad" concept.

4.3.1.6.2.3. Testing under 4.5.2.3. below for all vehicles.

4.3.1.7. System arming design requirements are:

4.3.1.7.1. For land launched vehicles, the system must be designed so all command and automatic flight termination system S&A devices, except lanyard armed S&A devices, are armed prior to ignition. A remote method of verifying the status of each S&A or EBW device must be provided. If an EBW system is used, each EBW capacitor bank must be fully charged and the EBW system placed in the armed position prior to ignition.

4.3.1.7.2. For land launched vehicles, the system must be designed so all firing capacitors used to initiate the ordnance train in the command and automatic flight termination system are thoroughly tested prior to flight. A remote indication of firing capacitor charge voltage must be provided.

4.3.1.7.3. For air or sea launched vehicles where propulsive ignition occurs prior to first motion (for example, aircraft launched vehicles), dual S&A or EBW devices must be used and delay time for arming the S&A or EBW devices must be the minimum consistent with launch crew safety.

4.3.1.7.4. For air or sea launched vehicles where propulsive ignition occurs after first motion, an ignition interlock must be provided so that engine ignition cannot occur unless:

4.3.1.7.4.1. The S&A devices are in the armed position for mechanically armed S&A devices.

4.3.1.7.4.2. The capacitor bank is fully charged for EBW systems.

4.3.1.8. In some cases, it may be necessary to "safe" the command or automatic flight termination system in flight, when the vehicle has proceeded beyond the limits of WSMC safety responsibility or to permit normal staging separations. In this case, the "safing" action is accomplished by one of the following methods:

4.3.1.8.1. A radio message transmitted from WSMC group equipment. The optional message in 4.3.3.3.12 below is normally used for this purpose.

4.3.1.8.2. An automatic function in the vehicle. Safing action in this case must depend on no less than two independent functions (from different sources) in the vehicle (for example, thrust chamber pressure decay and time from lift-off).

4.3.1.9. System monitor functions, such as arm, optional command, destruct, signal strength, etc., must be taken from points in the circuits that provide adequate and significant data for analysis and real-time use. Isolation is to be provided so that faults in the monitoring input circuits do not degrade the monitored systems. A short or open in an input circuit or the application of any negative or positive voltage up to 35 volts to such a circuit must not affect any other monitor circuits, 4.3.1.5.4 above.

4.3.1.10. Reliability requirements are:

4.3.1.10.1. The system must be designed to positively eliminate a single point failure resulting in the execution of undesired flight termination action or in the failure to execute desired flight termination action.

4.3.1.10.2. The flight termination system (command system and automatic system, as applicable) shall be designed to provide a probability of executing the required flight termination function of greater than 999 parts in 1,000.

4.3.1.10.3. A reliability analysis shall be performed on all individual components, such as, antennas, cables, receivers, as well as the complete Range Safety System. This

analysis shall consist of a probability analysis, failure cause and effect analysis, and safety analysis. The operation and environmental parameters of each component, as well as the complete system, will be designed to a reliability of 99.99 percent with a confidence factor of 95 percent. The final analysis will be presented in clear form with appropriate a posteriori reliability predictions and a priori reliability testing.

Methods of System Reliability Prediction.

(1) Event-space.
(2) Path-tracing.
(3) Cut set and tie set.
(4) Boolean logic.
(5) Fault tree analysis.
(6) Monte Carlo simulation.

Basic A Posteriori Reliability Prediction.

(1) Series
(2) Parallel
(3) Standby
(4) Load sharing
(5) Multimode function
(6) Conditional probability Bayes Theorem

4.3.2. Flight termination system, antenna system design are described as follows:

4.3.2.1. Adequate radio command coverage over 95 percent of the radiation sphere is required. To have adequate coverage, the entire command flight termination system (ground and airborne) must be submitted to an RF link analysis for the vehicle's trajectory where WSMC retains safety responsibility and command control action may be required. The gain margin for the link analysis must exceed plus 12 dB. Ground system RF characteristics are shown in Flight Termination Command System RF Radiation Characteristics (attachment 4).

4.3.2.2. To provide vehicle antenna radiation characteristics that satisfy radio command coverage requirements, the antenna system may include power splitters, combiners, hybrids, coaxial cables, and other passive components. The antenna system may be:

4.3.2.2.1. Independent for each receiver.

4.3.2.2.2. Coupled so that the RF signal power at a single antenna system output port is equally divided between each receiver.

4.3.3. Flight termination system receiver and decoder design are described as follows:

4.3.3.1. General design requirements - minimum acceptable requirements for receivers and decoders provide for standardization of receivers and decoders, compatibility with WSMC ground systems, efficient use of the assigned spectrum, and minimized susceptibility to interfering signals. The establishment of these requirements is not intended to restrict receiver and decoder design. Where the state-of-the-art permits improvement over these requirements, such improvements should be incorporated.

4.3.3.2. Command transmitter specifications - transmitter site geodetic coordinates and RF radiation characteristics are provided in attachment 4 (Flight Termination Command System RF Radiation Characteristics).

4.3.3.3. Receiver and decoder minimum specification - receivers and decoders must meet the minimum requirements for temperature and other environmental conditions they are subjected to during prelaunch checkout and flight.

4.3.3.3.1. Receiver and decoder WSMC interface - the receiver and decoder shall be designed to reliably receive and decode WSMC-transmitted radio command signals and actuate flight termination system devices.

4.3.3.3.2. Frequency band - the receiver shall be tunable to 416.5 MHz or 406.5 MHz. All new programs at WSMC are usually assigned 416.5 MHz (the primary frequency).

4.3.3.3.3. Deviation - the receiver and decoder shall operate normally with a deviation of plus and minus 30 kHz per tone with a tolerance of plus and minus 10 percent. The receiver and decoder shall not produce a decoder output at deviation levels of plus and minus 4 kHz or less per tone.

4.3.3.3.4. Sensitivity - the receiver shall have adequate sensitivity to maintain at least +12 dB gain margin through the end of powered flight or orbit insertion, 4.3.2.1 above.

4.3.3.3.5. Maximum usable RF input - the receiver and decoder shall be capable of operating within specification limits before, during, and after the application of a 1 volt RMS RF signal to its RF input.

4.3.3.3.6. Operating bandwidth - the receiver and decoder shall respond normally to all valid commands with the carrier frequency shifted within a minimum of plus and minus 45 kHz from the assigned operating frequency at an RF level equal to the specified sensitivity over the operating temperature range.

4.3.3.3.7. Continuous Wave (CW) RF bandwidth - the response to a CW signal at the assigned center frequency shall be 60 dB or more than the response at plus or minus 180 kHz from the assigned center frequency. CW rejection outside this bandwidth shall be greater than 60 dB. Note that this requirement is in reference to the assigned center frequency, and is not satisfied with a 360 kHz bandpass (unless the 360 kHz is exactly centered on F).

4.3.3.3.8. Noise margin - the AC noise level present at any point in the receiver capable of producing a logic function or command output must be 12 dB less than that which would cause the switching or activation levels for such circuits. A like margin is required for the DC circuitry.

4.3.3.3.9. CW peak to valley ratio - the peak to valley ratio must not exceed 3 dB within plus and minus 45 kHz from the assigned operating frequency.

4.3.3.3.10. Decoder or tones and frequencies - the decoder must be capable of processing four tones with center frequencies of:

Tone 1 (7.50 kHz)
Tone 2 (8.46 kHz)
Tone 4 (10.76 kHz)
Tone 5 (12.14 kHz)

4.3.3.3.11. Decoder channel bandwidth - the 2 dB bandwidth of each decoder channel must not be less than plus and minus 1 percent of the assigned tone center frequency. The 20 dB bandwidth of each decoder channel must not be greater than plus and minus 4 percent of the tone assigned center frequency.

4.3.3.3.12. Decoder outputs - the decoder provides four distinct and separate outputs. The outputs, in the form of electrical energy, are termed optional, arm, destruct, and monitor or check channel. The tones and logic sequence required to produce the decoder outputs are:

Decoder Output	Tone Logic
Optional	Tones 2 and 5 and not 1
Arm	Tones 1 and 5
Destruct	Tones 1 and 5 (Arm) followed by tones 1 and 2 and not 5
Monitor or check channel	Tone 4

Note 1: The decoder output for optional and destruct, which require the presence and absence of specific tones, occurs only when those conditions are met.

Note 2: After initiation of the arm output, the removal of tone 5, required for destruct output, must not result in the discontinuance of the arm output, nor should the removal of tone 5 prior to application of tone 2 inhibit the output of destruct. Therefore, tone 1 is the logic locking tone, and once initiated, the arm and destruct output continues until tone 1 is removed.

Note 3: The optional, arm, and destruct output electrical energy must meet the requirements specified for activation of the associated flight termination devices. The check channel output shall be capable of providing a minimum of two watts of power to the external load.

4.3.3.3.13. Response time - the time interval between the appearance of the last tone of a tone pair at the front end of the receiver and the occurrence of the respective decoder output must not exceed 15 milliseconds.

4.3.3.3.14. Output connectors - commands such as arm, optional command, and destruct shall be routed through a connector separate from all other circuits.

4.3.3.3.15. New technology - in the event a particular receiver design incorporates any new and substantially different technology, such as, but not limited to, digital signal processing, microprocessor control, solid state switching devices, phase lock loops, etc., all performance criteria set forth in this document must be met without compromise. In addition, no new anomalies or abnormal operations are allowed to occur. Error detection and correction techniques, or other means, must be used to prevent single-point failure modes, and any failure should be to a failsafe state. The design must not be susceptible to environmentally induced failures. Precautions should also be taken to prevent turn on and off glitches, entering an endless loop, and to provide for return to the main program in the event of a bad memory location.

4.3.3.3.16. Signal strength monitor - an RF input signal equal to the receiver's nominal (guaranteed) sensitivity level shall produce a DC voltage output, for monitoring purposes, that is discernable above the receiver's quiescent state output and is a 0.2 to 0.3 volt increase above the quiescent level. The monitor level shall then increase at a rate of approximately 1 volt for each 13 dB increase in the RF level. The DC output level shall reach a maximum (saturation) of between 4.5 to 5.0 volts with no less than 500 microvolts of RF applied. This output is either positive or negative and must not be ambiguous. It must permit a reasonable evaluation of incoming signal strengths

from 3 to 300 microvolts with no gross discontinuities in the response curve. The quiescent level, with no RF input to the receiver, must be a maximum of 0.5 volts. The load is assumed to be 10K ohm unless otherwise specified. The time constant must be 0.1 second or less.

4.3.3.3.17. Single point failure - failure of any one component must not cause a command output.

4.3.3.3.18. Performance - after being adjusted initially, the receiver and decoder must perform according to the requirements in the manual without subsequent adjustment.

4.3.3.3.19. Interference - the receiver and decoder must be designed to meet the requirements of MIL-STD-461B, methods CE01, CE03, CE06, CE07, CS01, CS02, CS03, CS04, CS05, CS06, CS07, RE02, RS02, and RS03. Limits A and B of MIL-STD 461B, figure 2-5, are changed to 60 dB above threshold at f_0. In addition, limit B must be at least 0 dB mw throughout the following frequency ranges: 2200-2300 MHz, 5600-5800 MHz and 9200-9600 MHz.

NOTE: Extreme environmental considerations in a given vehicle may require test limits more stringent than those called out in MIL-STD-461B, and conversely, lesser limits may be adequate in other vehicles; therefore, an analysis of the emitted radiations, and the susceptiblity of the receiver and decoder to interference, must be performed at the system level to establish that the interference characteristics identified and profiled in testing are compatible with the environment of the vehicle the receiver and decoder are to be used in.

4.3.3.3.20. Input requirements - the input voltage range must be specified, and the current in the commanded and uncommanded state noted in the specification.

NOTE: The receiver must meet the requirements of this document at any voltage level between the minimum and maximum specified.

4.3.3.3.21. Capture ratio - the application of an unmodulated RF signal at the assigned frequency of up to 80 percent of the desired modulated RF carrier must not cause the receiver to fail to meet the requirements of 4.3.3.3.4 above.

4.3.3.3.22. Abnormal voltage tolerance - the receiver must not produce an inadvertent command output because of input voltage below the minimum, or because of fluctuations of the input voltage. The receiver must not be damaged by such fluctuations.

4.3.3.3.23. Resistance and isolation - the resistance from each pin to common return, and also case ground, must be specified. Measurements that are polarity sensitive, such as those containing diodes, etc., shall be identified. In addition, significant pin to pin measurements shall be included where their inclusion will provide meaningful data relative to the reliability of the receiver.

4.3.3.3.24. Transient response - the tolerance to transient voltages shall be specified for each connector pin. Amplitude, polarity, and duration shall be identified. The ability of the receiver to meet the requirements of 4.3.3.3 above after the application of the specified transient, and that no output is produced during the transient, is required.

4.3.3.3.25. AM rejection - an RF input signal, at the operating frequency, specified in 4.3.3.3.2 above, of 7 microvolts ± 10 percent with 30 percent AM modulation and a 12 microvolt ± 10 percent signal with 50 percent modulation at any modulation frequency shall not produce an output from any decoder channel.

4.3.3.3.25.1. One hundred percent AM rejection - an RF input signal at the operating frequency specified in 4.3.3.3.2 above of 100 microvolts + 10 percent with 100 percent peak AM noise modulation at LPF 3 dB frequencies of 3.5 kHz or 7.0 kHz, shall not produce an output from any decoder channel. When the input signal is properly modulated to produce an output from a decoder channel, the 100 percent peak AM noise modulation at LPF 3 dB frequencies of 3.5 kHz to 7.0 kHz shall not inhibit that decoder input.

4.3.4. Flight termination system S&A or EBW device design requirements are:

4.3.4.1. Flight termination system S&A or EBW devices must meet the requirements of chapter 3.

4.3.4.2. For S&A devices, the remote armed indication shall not appear unless the device is in a position where the explosive ordnance train is 98 percent aligned, the ordnance barrier is 98 percent clear of a fully aligned ordnance train, or the overall alignment is such that the required system reliability and confidence level can be verified.

4.3.4.3. The S&A device shall be configured with dedicated connectors for redundant initiators (for example, initiating trains, including squibs, primers, and boosters) that are electrically and pyrotechnically independent of each other. Ordnance crossovers are not prohibited, provided overall reliability is maintained. Ordnance contained in flight termination system S&A devices shall meet the requirements of 4.3.5 below

4.3.4.4. Flight termination system S&A devices armed after vehicle first motion (lanyard, inertial, or similar device) shall be capable of being cycled to the arm position for checkout purposes prior to installation.

4.3.4.5. Flight termination system S&A device design must be compatible with the system arming requirements contained in 4.3.1.7 above

4.3.4.6. For EBW devices, the remote charged indication shall not appear unless the capacitor bank(s) is (are) 85 percent charged, or the overall system alignment is such that the required system reliability and confidence level can be verified.

4.3.4.7. The requirements of 4.3.4.3, 4.3.4.4. and 4.3.4.5 above also shall be applicable to EBW systems.

4.3.5. Flight termination system destruct ordnance design requirements are:

4.3.5.1. The destruct ordnance train shall be designed to reliably initiate with the energy provided by the command or automatic flight termination system(s) initiating circuitry. When initiated, the destruct action shall reliably propagate through the ordnance train, initiate destruct charges, and result in the appropriate destruct action required by 4.3.1.3 above.

4.3.5.2. Destruct ordnance shall be designed with particular emphasis on the requirements of 4.3.1.1 above. Tests on solid rocket motor destruct charges (linear shaped charges), containing 180 grains per foot waxed RDX, have shown that heat fluxes, greater than 100 BTU per ft per sec, can cause charge ignition and high order detonation in less than one second. The fact that upper stage exhaust during staging may engulf destruct charges and cause heat fluxes that exceed levels mentioned above should be carefully considered in the charge design for solid motors.

4.3.5.3. Destruct ordnance shall be designed to meet the requirements of chapter 3.

4.3.5.4. Maximum effort shall be made to design destruct ordnance in a configuration that enables initiators or other sensitive explosive components to be installed or connected late in the launch countdown through easily accessible openings in the vehicle.

4.3.5.5. Flight termination control system ordnance component total life, including shelf, installed, and service life under specified environmental conditions, is determined on an individual system basis. It is based on the age and the deterioration rate of each component. Once defined, extensions of shelf-life over one year may require requalification testing.

4.3.6. Flight termination system power supply design requirements are:

4.3.6.1. Airborne power supplies for the flight termination system shall be designed to preclude a short in, or failure of, any one battery causing a failure of the flight termination system. The batteries used in the flight termination system shall be independent of all other systems, including each other.

4.3.6.2. Batteries shall be of sufficient capacity to provide life for load and activation checks, launch countdown checks, and any necessary hold time so that at launch, sufficient battery life remains for flight, to the limits of WSMC/SE responsibility, plus 10 percent of the rated battery ampere hour capacity. For vehicles using solid propellants, a minimum of 30 additional minutes of battery life shall be provided so that flight termination action is possible until positive safing can be effected against inadvertent launch in case of hangfire or misfire condition.

4.3.6.3. The batteries should be easily accessible for inspection and replacement.

4.3.7. For flight termination system in-flight telemetry design, sufficient system data shall be telemetered to determine the adequacy of the flight termination system throughout powered flight and to aid in preflight and postflight analysis. TM data includes, but is not limited to, the following:

4.3.7.1. Flight termination control system:

4.3.7.1.1. Each command receiver and decoder discrete function output (optional command, arm, destruct, and check channel 4).

4.3.7.1.2. Each command receiver signal strength voltage (AGC).

NOTE: The destruct function output may be incorporated with the signal strength voltage telemetry channel. If so incorporated, the destruct function must cause signal strength voltage to rise a minimum 0.5 volts above the nondestruct AGC voltage.

4.3.7.1.3. Status of each S&A device.

4.3.7.1.4. Each power source voltage associated with the flight termination system.

4.3.7.1.5. Each firing unit logic voltage, high voltage, and trigger voltage for exploding bridge wire (EBW) systems.

4.3.7.1.6. Current of each power source associated with the flight termination system.

4.3.7.1.7. Each flight termination system bus voltage if different from the source voltages of 4.3.7.1.4 above.

4.3.7.2. Telemetry identification and calibration:

4.3.7.2.1. Range users shall provide a telemetry measurement listing in the program requirements document (PRD) or operations requirement document (OR). WSMC/SEO identifies the individual measurements to be used by review of these documents and any other available listings. Final decisions are made by WSMC/SEO to specifically identify which telemetry channels are mandatory and which are desired.

4.3.7.2.2. Calibration data on demodulated telemetry measurements are to be provided by the Range user to WSMC/SEO on request. The performance parameters are referenced against voltage levels for strip chart display and operator interpolation.

4.3.8. Flight termination ground systems design:

4.3.8.1. The use of unique, nonstandard, and unduly complex test equipment is discouraged.

4.3.8.2. A destruct simulator shall be provided for all command and automatic destruct system tests, wet dress rehearsals, combined system tests, countdown demonstration tests, or similar tests including the system tests required by this regulation. This simulator is to remain connected on the missile from the commencement of final prelaunch tests and launch day tests until the electrical connection of the flight initiators is accomplished. The simulator must provide:

4.3.8.2.1. Termination of the firing circuit with a device whose electrical characteristics match the electrical characteristics of the actual initiator. It shall be capable of providing certification of destruct surefire current.

4.3.8.2.2. A stray current monitor device (for example, fuse or automatic recording system) capable of indicating a minimum of one-tenth of the maximum no-fire current. It shall be connected and functional at all times, except when a demonstration of destructor surefire current is required.

4.3.8.3. A flight termination system control console shall be provided and maintained by the Range user. It shall be located in the launch control center, in a position that provides a viewing capability of the countdown time indicator and either the launch controller's console or the launch sequencer control console(s), as applicable. Physical size and design of the control console must provide seating accommodations for two persons with access to the console controls and monitors by either person. This console is designed to provide monitor and control capability for one person designated by the Range user to perform tasks defined by approved test procedures including countdown and launch manuals. The second position at this console is occupied by the RMCR. The RMCR supports test operations by analyzing system performance and evaluating flight readiness and also acts as the WSMC and Range user interface for resolution of flight safety problems. The RMCR also provides coordination of the final ready-to-launch system acceptance issued by the MFCO.

4.3.8.3.1. The following controls and monitors shall be provided on the control console:

4.3.8.3.1.1. Signal strength voltage (AGC) of each command receiver.

4.3.8.3.1.2. Controls and monitors for command receiver and decoder operation (ON and OFF, airborne and ground power mode).

4.3.8.3.1.3. Sensors to monitor each flight termination control system battery, bus, and ground power supply voltage (command and automatic, where applicable). Direct readouts are preferred; however, the option exists to provide either these or voltage comparator circuits with status lights.

4.3.8.3.1.4. Direct readout sensors to monitor the flight termination system EBW capacitor, automatic flight termination system firing capacitor charge, trigger and logic monitor voltages (where applicable).

4.3.8.3.1.5. Provisions for monitoring battery life, operating time, elapsed time since activation, or other means of monitoring energy remaining for flight.

4.3.8.3.1.6. Monitors and controls for the safe and armed status of all command and auto-destruct S&A devices.

4.3.8.3.1.7. Monitors for each command function at the terminal device.

4.3.8.3.1.8. Monitors for the decoder outputs of each receiver and decoder.

4.3.8.3.1.9. Monitors for vehicle-peculiar functions critical to Range safety, as identified in design reviews.

4.3.8.3.1.10. Certain flight termination system controls, such as receiver power switches, S&A devices, or similar devices in the console must be capable of being locked or safed to the OFF position if they are considered to be a safety hazard by WSMC/SEO.

4.3.8.3.1.11. Hold-fire capability that prevents ignition by stopping the launch sequencer or interrupting the ignition circuit. This capability must exist down to ignition. The control of this device is subject to predefined WSMC and Range user agreements.

4.3.8.3.1.12. Status and alert signaling system to activate status and alert remote display on the MFCO console to indicate "GO" or "NO-GO" status of the airborne flight termination system.

4.3.8.3.1.13. Manually activated lift-off switch to provide backup lift-off signal at missile launch and to permit prelaunch testing of missile lift-off interface to WSMC instrumentation. The option exists to locate this manual function elsewhere in the launch control center. It shall be activated by the launch crew member specified in the countdown manual.

4.3.8.3.2. In all cases, the provided monitors must be continuously available or available on demand to the RMCR.

4.4. Flight Termination System Manufacture. By its very nature, the flight termination system must be of the highest reliability. The consequences of this system failing to operate when required are extremely severe. This high reliability is ensured by placing the appropriate design and testing requirements on the individual components and on the system comprised of these components. Such reliability can be compromised if the flight termination system components are not subject to rigorous review and control during the manufacturing process.

4.4.1. The electronic-piece parts and materials used in the manufacture of flight termination system components must be of "Space Quality," as defined in MIL-STD-1547, and capable of meeting the general and detailed requirements set forth there.

4.4.2. The manufacturer of flight termination system components must have a quality program to make sure all machining, wiring, batching, shaping, soldering, basic production operations of any type, and processing and fabricating of any type is accomplished under controlled conditions. Controlled conditions include documented work instructions, adequate production equipment, and any special working environment. Documented work instructions are considered to be the criteria for much of the production, processing, and fabrication work. Some of these instructions are also the criteria for acceptable or unacceptable workmanship.

4.5. Flight Termination System Testing:

4.5.1. Flight termination system qualification testing shall be as follows:

4.5.1.1. System testing - all components of the flight termination system and methods of attaching or installing the system (command and automatic) must be tested to make sure of their environmental survivability (paragraph 4.3.1.1).

4.5.1.2. Reliability testing - the capability of the flight termination system to satisfy the requirements of 4.3.1.10 above shall be demonstrated by the Range users' analyses and tests.

4.5.1.3. Antenna testing - tests shall be performed to verify the antenna impedance compatibility with the receivers and to provide data for the RF link analysis (paragraph 4.3.2) and for the antenna patterns (paragraph 4.7.1.3.3).

4.5.1.4. Command receiver and decoder testing - receivers and decoders that have not been previously certified for use at WSMC must undergo qualification tests according to RCCRSG Document 313-80 and 4.2.2 above. Further, command receivers and decoders, certified for use at WSMC with a particular vehicle, may require additional qualification tests if the receiver and decoder are used with a different type launch vehicle. The qualification testing of two receiver and decoder units may be conducted by an independent agency or by the receiver and decoder vendor. The identification of the test agency is determined on a case-by-case basis through joint WSMC and Range user agreement. In addition, certain tests are performed to assure compatibility with specific WSMC ground systems, missile systems, and WSMC flight methodology. Testing by WSMC is according to a test plan developed in joint agreement between WSMC/SEO and the Range user. Further, tests conducted by WSMC will not include any testing that precludes future use of the test receivers as flight articles. The Range user is responsible for supplying two receivers to WSMC for testing.

4.5.1.5. EBW, HBW, and S&A device testing:

4.5.1.5.1. All EBW , HBW, and S&A devices must meet the requirements of chapter 3 and 4.3.4 above.

4.5.1.5.2. Tests must be performed to show the capability of the propagation of destruct action from the initiator to the destruct charge.

4.5.1.5.3. Devices that are armed by lanyard or a similar device must be capable of being switched to the arm position for checkout purposes.

4.5.1.6. Ordnance testing - tests must be performed to show the capability of the destruct charges to accomplish the destruct action required by 4.3.1.3. above.

4.5.1.7. Power supply testing - tests and analyses must be performed to determine battery-load life considering the loads that will be imposed during battery activation, load tests, prelaunch system tests, destruct tests, countdown, hold time, and flight. Provision must be made for misfire and hangfire situations.

4.5.1.8. Associated component testing - tests of other flight termination system components not specifically called out in this regulation are tailored to those components with test criteria suitable to make sure of adequate performance at the required system reliability level results.

4.5.1.9. Flight termination system modification requalification testing - retesting is required when significant modifications or changes are made (paragraph 4.2.5) to the system or components that require specific qualification testing. The requirements for

retest depend on the extent and type of modifications being made, and are determined by WSMC/SEO through joint WSMC and Range user consideration on a case-by-case basis.

4.5.2. Receipt through launch testing:

4.5.2.1. Radio command link - normally, the antenna, receivers and decoders of the radio command link are tested both individually and as a system at WSMC as part of the vehicle's receipt through launch readiness sequence testing. However, where mission requirements, economy, or special circumstances prevail, a concept termed "factory-to-pad" may be authorized for Range users whose launch vehicle assembly facility is not located at WSMC. This concept permits some of the testing, normally done at WSMC, to be accomplished at the vehicle assembly facility, with reverification testing at WSMC. Authorization to conduct testing under the factory-to-pad concept requires a waiver obtained according to 4.2.1 and 1.7 above. The requirements for both the factory-to-pad and nonfactory-to-pad (all testing at WSMC) test methods are specified as follows:

4.5.2.1.1. Factory-to-pad:

4.5.2.1.1.1. The following tests are performed at the launch vehicle assembly facility:

4.5.2.1.1.1.1. Each receiver and decoder is performance tested in a laboratory type environment prior to final installation of the units into the launch vehicle. The tests determine the following performance characteristics:

4.5.2.1.1.1.1.1. Receiver and decoder RF sensitivity for optional, arm, destruct, and monitor messages at the minimum, nominal, and maximum DC voltage input (paragraph 4.3.3.3.4).

4.5.2.1.1.1.1.2. Sixty dB CW bandwidth (paragraph 4.3.3.3.7).

4.5.2.1.1.1.1.3. Operating bandwidth also includes a test in a CW characteristic mode to determine if any peaks or valleys exist within the operational bandwidth (paragraphs 4.3.3.3.6 and 4.3.3.3.9).

4.5.2.1.1.1.1.4. Deviation sensitivity and compatibility (paragraph 4.3.3.3.3).

4.5.2.1.1.1.1.5. Each decoder channel tested for 2 and 20 dB bandwidth on the receiver and decoder (paragraph 4.3.3.3.11).

NOTE: For receiver or decoders susceptible to overdeviation at the 20 dB level, the 20 dB bandwidth measurement will be made prior to installation of the filter into the decoder. The test will be repeated in the receipt-through-launch testing at a level as near as possible to 20 dB that will not result in overdeviation of the receiver or decoder.

4.5.2.1.1.1.1.6. Decoder abnormal logic compatibility (paragraph 4.3.3.3.12).

4.5.2.1.1.1.1.7. Response time (paragraph 4.3.3.3.13).

4.5.2.1.1.1.1.8. Isolation and input current (paragraphs 4.3.3.3.20 and 4.3.3.3.23).

4.5.2.1.1.1.1.9. Decoder output electrical energy for optional, arm, destruct, and monitor (paragraph 4.3.3.3.12, note 3).

4.5.2.1.1.1.1.10. Usable RF input (paragraph 4.3.3.3.5).

4.5.2.1.1.1.1.11. Capture ratio (paragraph 4.3.3.3.21).

4.5.2.1.1.1.1.12. Relative signal strength curve.

4.5.2.1.1.1.1.13. AM modulation rejection (paragraph 4.3.3.3.25).

NOTE: Additionally, other test areas may be required, dependent on any unique or additional missile system or receiver and decoder requirements.

4.5.2.1.1.1.2. A voltage standing wave ratio (VSWR) test is performed on the antenna system of each launch vehicle.

4.5.2.1.1.1.3. An in-vehicle RF system sensitivity test is conducted after the receivers and decoders are installed into the vehicle and connected to the antenna system. The test is conducted in an RF closed loop mode utilizing a calibrated RF cable and calibrated antenna couplers (hats). The test determines the RF sensitivity, referenced to the surface of each antenna, for each receiver and decoder output of an optional, arm, destruct, and monitor message. The receiver and decoder DC voltage supply is at its nominal value.

4.5.2.1.1.2. An in-vehicle receiver and decoder performance test is conducted at WSMC. The test is performed as late in the receipt through launch readiness sequence as possible (normally within 90 days of launch). The test is conducted in the RF closed loop mode utilizing a calibrated RF cable and calibrated antenna couplers provided by the Range user. The test is performed by WSMC Center Technical Services Contractor (CTSC). The performance characteristics derived from this test are compared with the characteristics derived from the tests at the launch vehicle assembly facility. If no significant differences are noted (test equipment tolerance factors considered), the RF command link system is considered acceptable and undamaged by vehicle shipment or storage. Any change of components or disconnection of any portion of the RF command link subsequent to this test requires complete retesting. The test determines the following performance characteristics:

4.5.2.1.1.2.1. The RF sensitivity, referenced to the surface of each antenna, for each receiver and decoder output of an optional, arm, destruct, and monitor message. The receiver and decoder DC voltage supply is at its nominal value.

4.5.2.1.1.2.2. Sixty dB CW bandwidth for receiver and decoder.

4.5.2.1.1.2.3. Operating bandwidth for receiver and decoder.

4.5.2.1.1.2.4. Deviation sensitivity and compatibility for receiver and decoder.

4.5.2.1.1.2.5. Each decoder channel tested for 2 and 20 dB bandwidth on the receiver and decoder.

NOTE: For receivers or decoders susceptible to overdeviation at the 20 dB level, the 20 dB bandwidth measurement will be made prior to installation of the filter into the decoder. The test will be repeated in the receipt through launch testing at a level as near as possible to 20 dB that will not result in overdeviation of the receiver or decoder.

4.5.2.1.1.2.6. Decoder abnormal logic compatibility of each receiver and decoder.

4.5.2.1.1.2.7. Relative signal strength curve for each receiver and decoder (paragraph 4.3.3.3.16).

4.5.2.1.1.2.8. Amplitude modulation rejection testing at 100 percent.

NOTE: Additionally, other testing areas may be required, dependent on any unique or additional missile system or receiver and decoder requirements.

4.5.2.1.2. For nonfactory-to-pad, the following tests must be performed at WSMC:

4.5.2.1.2.1. A VSWR test is performed on the antenna system of each launch vehicle.

4.5.2.1.2.2. Each receiver and decoder is performance tested at the WSMC RF Measurements Laboratory. The test is performed as late in the receipt through launch readiness sequence as possible (normally within 90 days of launch). The tests determine the following performance characteristics:

4.5.2.1.2.2.1. Receiver and decoder RF sensitivity for optional, arm, destruct, and monitor messages at the minimum, nominal and maximum DC voltage input.

4.5.2.1.2.2.2. Sixty dB CW bandwidth.

4.5.2.1.2.2.3. Operating bandwidth - this also includes a test in a CW characteristic mode to determine if any peaks or valleys exist within the operating bandwidth (paragraphs 4.3.3.3.6 and 4.3.3.3.9).

4.5.2.1.2.2.4. Deviation sensitivity and compatibility (paragraph 4.3.3.3.3).

4.5.2.1.2.2.5. Each decoder channel tested for 2 and 20 dB bandwidth (paragraph 4.3.3.3.11).

NOTE: For receiver and decoders susceptible to overdeviation at the 20 dB level, the 20 dB bandwidth measurement will be made prior to installation of the filter into the decoder. The test will be repeated in the receipt through launch testing at a level as near as possible to 20 dB that will not result in overdeviation of the receiver or decoder.

4.5.2.1.2.2.6. Decoder abnormal logic compatibility (paragraph 4.3.3.3.12).

4.5.2.1.2.2.7. Response time (paragraph 4.3.3.3.13).

4.5.2.1.2.2.8. Isolation and input current (paragraphs 4.3.3.3.20 and 4.3.3.3.23).

4.5.2.1.2.2.9. Decoder output electrical energy for optional, arm, destruct, and monitor (paragraph 4.3.3.3.12, Note 3).

4.5.2.1.2.2.10. Usable RF input (paragraph 4.3.3.3.5).

4.5.2.1.2.2.11. Capture ratio (paragraph 4.3.3.3.21).

4.5.2.1.2.2.12. Relative signal strength curve (paragraph 4.3.3.3.16).

4.5.2.1.2.2.13. Amplitude modulation rejection at 100 percent (paragraph 4.3.3.3.25).

NOTE: Additionally, other testing areas may be required depending on unique or additional missile system or receiver and decoder requirements.

4.5.2.1.2.3. A command link RF sensitivity test must be performed after final installation of the receivers and decoders and their connection to the antenna system. The test is conducted in an RF closed loop mode utilizing a calibrated RF cable and calibrated antenna couplers (hats) furnished by the Range user. The test is performed by WSMC RF laboratory personnel utilizing the RF measurements laboratory mobile test van. The test determines the RF sensitivity, referenced to the surface of each antenna, for each receiver and decoder output of optional, arm, destruct, and monitor message. The receiver and decoder DC voltage supply is at its nominal level.

4.5.2.2. EBW systems or S&A device testing requirements:

4.5.2.2.1. A quality assurance check will be made on all S&A and EBW devices. This test must be performed at WSMC and consists of a physical check for signs of corrosion, or similar defects, general physical inspection and electrical check that includes arming and safing voltages, continuity, and resistance checks in both the "armed and safe" positions to make sure initiators are neither shorted nor open circuited. This check must be accomplished within five calendar days of installation of the S&A or EBW devices on the vehicle.

4.5.2.2.2. If the flight termination system S&A and EBW devices have been electrically connected and the test subsequently scrubbed, a removal and recheck of the device may be required. Any decision to remove or recheck is coordinated with the Range user and depends on:

4.5.2.2.2.1. Flight termination system missile interface design (for example, if removal is necessary for retest of the flight termination system).

4.5.2.2.2.2. Hazards involved by leaving the device on the missile during recycle.

4.5.2.2.2.3. If the device has been subjected to unusual operating or environmental conditions.

4.5.2.2.2.4. Previous history and reliability of the device.

4.5.2.3. A verification check of the entire flight termination control system must be accomplished on each vehicle after the system has been completely installed and all connections made (the destruct simulators will substitute for the destruct initiators). It includes, as applicable to each particular vehicle, a check of the command system, automatic system, fail safe system, holdfire device, lift-off switch, and status and alert lights. The command system check is performed on internal power (flight batteries) in an RF open loop mode with the WSMC ground transmitting equipment. For the automatic system and fail safe system check, the option exists to perform the check on flight batteries or to perform a separate load check on those batteries. The purpose of the verification check is to determine proper operation and readiness of all components and elements of the system, including ground transmitting equipment, vehicle receiver and decoders, flight batteries, nondestructive thrust termination actuating devices, and circuitry to the point where the destruct initiators will be electrically connected. Verification checks are incorporated into the Range user's countdown so they are conducted as close to lift-off as is feasible. Ideally, the verification checks and subsequent connection of the destruct initiators should be the last two tasks accomplished prior to clearing the launch pad for launch. Time sequencing of the verification checks into the launch countdown is determined through joint WSMC and Range user consideration as part of the flight termination system approval.

4.5.2.3.1. If, after the verification checks have been completed during the initial launch countdown, launch is postponed beyond the launch window time (for example, a 24 hour launch slip), the Range user shall include provisions for reaccomplishment of the verification check in the subsequent countdown. It is recognized, however, that some Range users may not be able to accomplish a complete verification check within a short time frame launch recycle. In this instance, the system may be revalidated by the accomplishment of a limited verification check. This limited verification check concept is acceptable only where a rescheduled launch window could not be met because of the time involved to configure the missile system, perform the verification check, and reconfigure the missile for launch. WSMC/SEO may designate a missile system as a limited verification check vehicle during the system design period through joint WSMC and Range user determination. At this time, the details and extent of the limited verification checks are fully identified so that any special additions or capabilities

necessary to accomplish the limited verification checks can be incorporated into system design. Further, prior to flight termination system approval, complete WSMC and Range user agreement must be reached outlining the conditions where limited verification checks will be accepted in lieu of a complete verification check. These conditions, as agreed to, become part of the flight termination system approval. As with the complete verification check, the limited verification tests are incorporated into the Range user's countdown so they are conducted as close to lift-off as feasible. Accomplishment of a limited verification check may not be acceptable if the system has been compromised (for example, an anomaly affecting range safety, radiation considerations, the disconnection or replacement of certain flight termination system components, or adverse environmental conditions such as moisture or temperature that have the potential to degrade system performance). Should additional launch postponements occur beyond the initial 24 hour postponement, WSMC/SEO evaluates available information and determines if the full scale system test must be repeated or if the limited verification test is adequate.

4.5.2.4. All manually activated batteries for use with flight termination systems are activated (built-up) at WSMC. The build-up procedure includes necessary testing to make sure of proper battery activation. The time interval between the test and launch lift-off must not exceed the activated stand time battery specification. Final readiness tests for both manually and remotely activated batteries are accomplished during the system verification check.

4.5.2.5. Test equipment calibration - equipment used for checkout of the flight termination system must be calibrated on a periodic basis. This calibration must be accomplished on all test equipment used to support tests and certifications associated with processing, launch, and flight of missiles at WSMC. The equipment of concern includes, but is not limited to, the pad safety console, the flight termination control system console, other blockhouse consoles, antenna couplers (hats), calibrated coaxial cables used for RF sensitivity, and insertion loss tests. Standard test equipment should be routinely checked by the local precision measurements equipment lab (PMEL); specialized or dedicated mock-up or portable, program-peculiar equipment is checked by WSMC (RF measurements laboratory), the Range user's approved facility, or equivalent agency.

4.6. Test Attendance Requirements. A representative of WSMC/SEO will attend certain system and component level flight termination system recurring tests, installation functions, and missile system operations. For preliminary planning purposes, the general group of tests, installation functions, and operations that may require attendance are listed below. For complete clarification, the firm requirements that apply to each missile system program are specified by separate correspondence to each Range user by WSMC/SEO. Such correspondence identifies tests that require mandatory or optional attendance, that are to be attended on a surveillance basis only, and that require only notification action for scheduling purposes.

4.6.1. Command receiver and decoder performance test.

4.6.2. Range safety transponder performance test.

4.6.3. Antenna system VSWR and RF insertion loss test.

4.6.4. RF closed loop antenna and receiver system RF sensitivity test.

4.6.5. Premature separation (automatic system) operation test.

4.6.6. Flight termination system associated ground system test.

4.6.7. Preliminary flight termination system RF open loop test. (This is not a WSMC required test. However, the WSMC user normally conducts several of these tests during the missile receipt through launch process.)

4.6.8. Battery activation and load test.

4.6.9. S&A device test.

4.6.10. Flight termination system installation inspection.

4.6.11. Launch countdown flight termination system RF open loop test.

4.6.12. Destruct ordnance final connection and prearming function.

4.6.13. Launch control center functions during launch terminal countdown.

4.7. Data Requirements. DD Form 1664, Data Item Description (LRA), is used to identify specific program requirements whenever possible.

4.7.1. The following data must be submitted in support of a flight termination system proposal. All schematics, functional diagrams, and operational manuals must have well-defined, standard Institute of Electrical and Electronics Engineers (IEEE) or MIL-SPEC terminology and symbols.

4.7.1.1. Design data requirements are as follows:

4.7.1.1.1. Flight system data requirements are:

4.7.1.1.1.1. Diagrams showing the location of all flight termination system components on the vehicle, and a block diagram of the entire system showing the location of each component and element in the vehicle.

4.7.1.1.1.2. Detailed schematics and functional diagrams of all system and subsystems including:

4.7.1.1.1.2.1. All components, power sources, relay resistors, diodes, switching devices, connectors with pin numbers, including manufacturer specifications and tolerances.

4.7.1.1.1.2.2. Other missile system components or elements that interface with, or share common usage with, the flight termination system (for example, engine shut down valves).

4.7.1.1.1.2.3. Illustrated breakdown drawings of all mechanically operated components, including composition and tolerances.

4.7.1.1.1.3. Detailed function description of the operations of each component the of the system.

4.7.1.1.1.4. Data showing compliance with guidelines set forth in MIL-STD 785A.

4.7.1.1.1.5. Identify reliability model input and apportionment and prediction for all system components and elements.

4.7.1.1.1.6. Identify reliability of all system components and elements executing a required system function.

4.7.1.1.1.7. A Failure Mode and Effect Analysis (FMEA).

4.7.1.1.1.8. Identify reliability critical items, including, but not limited to, those considered within the reliability and FMEA of the system.

4.7.1.1.1.9. A fault tree analysis.

4.7.1.1.1.10. A discussion determining effects of the reliability of the system components and elements resulting from storage, shelf life, packaging, transportation, handling and maintenance.

4.7.1.1.1.11. Flight hardware subsystem data:

4.7.1.1.1.11.1. A detailed description of the antenna system, including specification and operation manuals, as appropriate.

4.7.1.1.1.11.2. Transponder - copies of the specification, schematics, operation manuals and checkout procedures.

4.7.1.1.1.11.3. Command receiver and decoder - copies of the specification, schematics, operation manuals and checkout procedures.

4.7.1.1.1.11.4. S&A, HBW, and EBW devices - copies of the specification and operation manuals. This must include all electrical characteristics and shelf-life of the electro-explosive devices.

4.7.1.1.1.11.5. Ordnance - a complete description of the ordnance, including its composition, connections, and methods of attachment.

4.7.1.1.1.11.6. Power supply - copies of the airborne battery supply specification, operation manuals, and checkout procedures.

4.7.1.1.1.11.7. Telemetry - a complete description outlining the method of compliance with 4.3.7 above.

4.7.1.1.2. Ground system data test equipment requirements are:

4.7.1.1.2.1. A complete listing and description of all test equipment, including contractor-peculiar test equipment that is utilized in checkout of the system and its individual components and elements.

4.7.1.1.2.2. Copies of all specification and operation manuals for all contractor peculiar test equipment.

4.7.1.1.2.3. Complete description of the design of the flight termination control system console (paragraph 4.3.8.3), including graphic illustrations, detailed schematics, functional diagrams, and proposed locations in the launch control center.

4.7.1.2. Qualification and acceptance test procedure - copies of the individual qualification and acceptance test plans and procedures identified during the system design period.

4.7.1.3. Qualification test results - pertinent portions of the test result data may be extracted from the test reports and submitted in condensed form.

4.7.1.3.1. Environmental survivability - test result data and information to show compliance with 4.3.1.6 above.

4.7.1.3.2. Reliability - test result data, as applicable, to show compliance with 4.3.1.10 above.

4.7.1.3.3. Antenna - the antenna patterns and information according to 4.3.2. and 4.5.1.3 above. The antenna patterns must be provided on magnetic tape and in graphical representation according to SAMTOR 80-4, Missile Antenna Data Requirements.

4.7.1.3.4. Command receiver and decoder - test results of qualification tests according to 4.5.1.4 above.

4.7.1.3.5. S&A, HBW, and EBW devices - test results showing the propagation of destruct action from the initiators to the destruct charges and requirements in 4.5.1.5 above.

4.7.1.3.6. Ordnance - test results showing the ability of the destruct charges to accomplish the destruct action according to 4.5.1.6 above.

4.7.1.3.7. Power supply - battery load test analysis showing compliance with 4.3.6.2 above.

4.7.1.4. Recurring test procedure requirements are:

4.7.1.4.1. System - detailed procedure for the verification check and limited reverification check, including an outline of the launch countdown task sequence flow (paragraphs 4.5.2.3 and 4.5.2.3.1).

4.7.1.4.2. Antenna system:

4.7.1.4.2.1. Detailed procedures for the antenna VSWR and RF line insertion loss tests (paragraphs 4.5.2.1.1.1.2 and 4.5.2.1.2.1).

4.7.1.4.2.2. Detailed procedures for the RF system sensitivity test to be performed at the launch vehicle assembly facility for the "factory-to-pad" concept vehicles (paragraph 4.5.2.1.1.1.3).

4.7.1.4.3. Command receiver and decoder:

4.7.1.4.3.1. Detailed requirements for the bench test mode performance test (paragraphs 4.5.2.1.1.1.1 or 4.5.2.1.2.2.).

4.7.1.4.3.2. Detailed requirements for the RF closed and open loop mode test (paragraphs 4.5.2.1.2.3 and 4.5.2.3).

4.7.1.4.4. S&A, HBW and EBW devices - detailed procedure for the S&A, HBW and EBW device tests (paragraphs 4.5.1.5 and 4.5.2.2).

4.7.1.4.5. Power supply - detailed procedure for the battery test (paragraph 4.5.2.4).

4.7.1.4.6. Ground system - detailed procedures for calibration of the control console (paragraph 4.3.8.3).

4.7.1.5. Installation procedure - detailed procedures for installing the system and components.

4.7.1.6. All preliminary system proposal data, in whole or in part, should be submitted to WSMC/SEO, informally, as soon as available (paragraph 4.2.1). The final (critical) system proposal data submission must be the formal Flight Termination System Report (FTSR). The FTSR should be a single volume document. Data submittal items that cannot

be included in that document because of size or configuration (such as procedures, component operation and specification manuals, and magnetic tapes), are referenced in the applicable section and submitted as attachments. All data submissions in support of modifications or changes to either the preliminary or final proposal must be titled and formatted similarly to the original. The FTSR is prepared using the following format:

4.7.1.6.1. Introduction - outlines the contents of the report and includes any deviations to this document agreed to during the design period (paragraph 4.2.1).

4.7.1.6.2. General system description - a brief general description and block diagram of the flight termination system (paragraph 4.7.1.1.1.1).

4.7.1.6.3. Detailed system description - design data specified in 4.7.1.1.1.2 and 4.7.1.1.2 above.

4.7.1.6.4. System qualification testing - system qualification test data specified in 4.7.1.2 and 4.7.1.3 above.

4.7.1.6.5. System recurring test procedures - system recurring test procedures specified in 4.7.1.4. and 4.7.1.5 above.

4.7.1.6.6. Other comments or information - the title and information of this section is left to the discretion of the Range user or their contractor, but should include items not covered in previous sections that are pertinent to the system, launch, or complex being used. As an example, such information normally involves data concerning the GSE.

4.7.2. Recurring data requirements:

4.7.2.1. Test results - the following data, relative to the specific system for each individual launch, must be submitted to WSMC/SEO on a timely basis (at least 30 days prior to launch) to facilitate a launch ready status.

4.7.2.1.1. Antenna data:

4.7.2.1.1.1. Results of the VSWR and RF line insertion loss test.

4.7.2.1.1.2. Results of the antenna and receiver system sensitivity test.

4.7.2.1.2. Command receiver and decoder:

4.7.2.1.2.1. Results of the receiver and decoder vendor acceptance test and bench test.

4.7.2.1.2.2. Factory-to-pad concept - results of the receiver or decoder RF closed loop performance test.

4.7.2.1.3. S&A, HBW and EBW devices - results of the S&A, HBW and EBW device tests.

4.7.2.1.4. Power supply - results of the battery activation and load test.

4.7.2.2. Calibration results - the following data relative to calibration of the ground system must be provided to WSMC/SEO according to the specified calibration time schedule.

4.7.2.2.1. Test equipment - all applicable data, such as meter correction factors and the electrical energy requirement for circuit breaker trip where used as the squib simulator impedance.

4.7.2.2.2. Control consoles - all applicable data, such as meter calibration factors and the determinant value levels used in "GO" or "NO-GO" comparison circuitry.

4.7.3. Failure report:

4.7.3.1. Failure to meet specifications - the failure of a flight termination system or system component to meet WSMC approved specifications after delivery from the vendor must be reported in writing within 15 days of the date the failure is noted. WSMC Form 99, Airborne Flight Termination System Failure Report, or its equivalent, is used for this purpose. This requirement includes failure of tests conducted at the vehicle contractor's plant and at WSMC. A formal report containing a description of the failure, an analysis of the failure, and details of corrective action taken, must be submitted within 60 days of the failure for approval according to 4.2.4 above.

4.7.3.2. Failure to meet WSMC test requirements - failure of a flight termination system or flight termination system component to meet test procedure requirements during any test contained in 4.5.2 above must be reported, by telephone, to WSMC/SEO within 24 hours of the failure. A written report containing a description and analysis of the failure and details of corrective action taken must be submitted for approval according to 4.2.4 above before that component or system will be approved for flight.

4.7.3.3. In-flight failure - any in-flight anomaly occurring in a flight termination system must be reported immediately to WSMC/SEO. A detailed written report containing a description and analysis of the anomaly, and details of corrective action taken, must be submitted for approval according to 4.2.4 above before the system will be approved for any subsequent flights.

4.7.4. Flight termination system modification data - modification proposals must be submitted for approval according to 4.2.5 above, with sufficient leadtime (a minimum of 60 days before launch) for evaluation to avoid delay of launch schedules. The proposal must include all data applicable to the modification that are required in the approval of a new system.

4.8. Tracking beacon and transponder systems:

4.8.1. Discussion:

4.8.1.1. The requirement for an in-vehicle tracking aid is stated in 1.9 above.

4.8.1.2. The requirements in this section apply to both noncoherent and coherent tracking transponders.

4.8.2. The approval requirements detailed in 4.2 above apply to tracking beacon and transponder systems.

4.8.3. Design requirements:

4.8.3.1. General:

4.8.3.1.1. All missiles flown on the WTR must contain an airborne tracking system capable of operating within the parameters established for normal operation of the associated WSMC ground tracking facilities.

4.8.3.1.2. The design, manufacture, and installation of the tracking beacon and transponder system must conform to the requirements contained in this chapter.

4.8.3.1.3. WSMC will assign individual launch agencies transponder interrogation pulse codes to facilitate multiple launch operations and prevent RF environmental interference.

4.8.3.1.4. All transponders launched at WSMC are double pulse interrogation coded, unless specifically approved as mission peculiar.

4.8.3.2. Environmental survivability - all components of the tracking beacon and transponder system, and methods of attaching or installing the system, must be designed and qualified to make sure the system has the ability to function normally under all environmental conditions it will be subjected to (for example, extremes of altitude, temperature, pressure, vibrations, and acceleration). This includes the environment that may be experienced by the vehicle while it is within the limits of WSMC/SE responsibility.

4.8.3.3. Testing survivability - all circuitry, elements, and components of the tracking beacon and transponder system must be capable of withstanding the repetitive functioning incurred during prelaunch testing without degradation.

4.8.3.4. Antenna system - the antenna system must provide adequate coverage over 95 percent of the radiating sphere to assure maximum interrogation and reply signal levels for reliable tracking along all possible flight paths within command control limits of WSMC responsibility. To demonstrate adequate coverage, a complete link analysis shall be performed. The gain margin for the link analysis must not be less than 0 dB. The WSMC radar characteristics are shown in table 4-1. Further information on the radar characteristics will be supplied upon request.

Coherent Radars	EIRP (dBm)	Req. Sig Pwr. (dBm/m2
VAFB TPQ-18	+142.6	-104.5
PP FPQ-6	+144.0	-104.5
MUGU FPS-16 #4	+138.7	-97.5
SNI FPS-16 #3	+138.7	-97.5
WSMC* MPS-36	+131.0	-92.5

Table 4-1. WSMC Radar Characteristics.

4.8.3.5. Transponder - the transponder must meet any combination of the following requirements, simultaneously and without readjustment, under any or all required environmental, mechanical, and electrical flight conditions.

4.8.3.5.1. Environmental conditions - transponder as a minimum must meet requirements of IRIG Document 115-80.

4.8.3.5.1.1. Design reliability - must meet at least a 0.995 success ratio.

4.8.3.5.1.2. Operational life - meet all operational requirements from receipt through launch.

4.8.3.5.1.3. Stabilization time - as required for stabilization between transponder final power application and missile launch time.

4.8.3.5.1.4. Radio Frequency Interference (RFI) requirements - MIL-STD-462, Measurement of Electromagnetic Interference Characteristics, and MIL-STD-461B, Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference.

4.8.3.5.1.5. Antenna short or open - the transponder must meet all requirements after removal of an anomaly from the antenna terminal.

4.8.3.5.1.6. Transponder frequency separation - fifty MHz minimum (except coherent transponders) transpond to interrogate frequency.

4.8.3.5.1.7. PRF response - a 100 to 2,600 pps minimum.

4.8.3.5.1.8. Valid interrogation response - must respond to 99 percent of valid interrogations above minimum trigger sensitivity under all operating conditions.

4.8.3.5.1.9. System fixed delay - must have at least one fixed delay setting of 2.5 microseconds, plus or minus 0.2 microsecond maximum, set at a minus 55 dBm signal level.

4.8.3.5.1.10. Power source switching - the operational performance requirements of the transponder must not be degraded by its internal or external power supply or switching between the power source.

4.8.3.5.1.11. Power delay timer - a 120 seconds maximum power loss without timer recycle.

4.8.3.5.1.12. Fuses and circuit breakers - not allowed.

4.8.3.5.2. Receiver:

4.8.3.5.2.1. Tunable frequency range - a 5400 to 5900 MHz minimum continuous range, or incremental bands.

4.8.3.5.2.2. Frequency variation acceptance - plus or minus 2 MHz minimum from tuned center frequency with response to valid interrogation modes.

4.8.3.5.2.3. Frequency stability - plus or minus 3 MHz maximum from tuned center frequency under all operating conditions and sources of drift.

4.8.3.5.2.4. Trigger sensitivity - a -70 dBm minimum with 99 percent response and less than 5 pps response to random noise.

4.8.3.5.2.5. Dynamic range - zero to -65 dBm minimum with less than .03 microsecond delay variation (absolute).

4.8.3.5.2.6. Maximum input signal - zero dBm minimum with 99 percent average response to valid interrogations.

4.8.3.5.2.7. Off-frequency rejection - eighty dB minimum from 0.15 to 10,000 MHz, excluding tuning range frequencies.

4.8.3.5.2.8. Image rejection - sixty dB minimum.

4.8.3.5.2.9. Three dB bandwidth - eleven MHz, plus or minus three MHz maximum.

4.8.3.5.2.10. Sixty dB bandwidth - sixty MHz maximum.

4.8.3.5.2.11. Pulse width acceptance - a 0.25 microsecond to 2.0 microseconds minimum single pulse; 0.25 microsecond to 1.0 microseconds minimum multiple pulse interrogation.

4.8.3.5.2.12. Rise time acceptance - a 0.2 microsecond or less under all operating conditions.

4.8.3.5.2.13. Fall time acceptance - a 0.5 microsecond or less under all operating conditions.

4.8.3.5.2.14. Interrogation modes - single and double pulse minimum.

4.8.3.5.2.15. Pulse code spacing - a 3.0 to 12.0 microseconds minimum.

4.8.3.5.2.16. Decoder positive pulse accept limits - the interrogation pulses shall be accepted if the pulse spacing varies by 0.15 microsecond or less from the nominal preselected spacing.

4.8.3.5.2.17. Decoder positive pulse reject limits - the interrogation pulses shall be rejected if the pulse spacing varies by 0.30 microsecond or greater from the nominal preselected spacing.

4.8.3.5.2.18. Decoder immunity - no response to single pulse interrogation under all coded operational conditions.

4.8.3.5.2.19. CW immunity - no response to sequenced coded (100 microseconds duration) and uncoded CW signal levels of zero dBm or less under all operating conditions.

4.8.3.5.3. Transmitter:

4.8.3.5.3.1. Tunable frequency range - a 5400 to 5900 MHz minimum continuous range of 5 incremental 100 MHz bands.

4.8.3.5.3.2. Frequency stability - plus or minus 3.0 Mhz maximum from assigned frequency after an initial warm-up period under all operating conditions.

4.8.3.5.3.3. Frequency drift range - one MHz per minute maximum under all conditions.

4.8.3.5.3.4. Peak power output - specific power requirements are determined on individual program basis.

4.8.3.5.3.5. Pulse RF spectrum - not to exceed 3.0 divided by the pulse width in microseconds measured at the quarter power points.

4.8.3.5.3.6. Pulse frequency jitter - plus or minus 0.5 MHz maximum pulse-to-pulse.

4.8.3.5.3.7. Pulse characteristic - single pulse.

4.8.3.5.3.8. Pulse width - a 0.25 to 1.0 microseconds except for coherent transponders.

4.8.3.5.3.9. Pulse width jitter - a 0.06 microsecond maximum peak-to-peak measured at half power points.

4.8.3.5.3.10. Pulse amplitude (voltage level) variation - a 1.0 dB maximum over operating PRF range.

4.8.3.5.3.11. Pulse amplitude (voltage level) jitter - plus or minus 0.5 dB maximum peak-to-peak.

4.8.3.5.3.12. Pulse rise time - a 0.1 microsecond maximum.

4.8.3.5.3.13. Pulse fall time - a 0.2 microsecond maximum.

4.8.3.5.3.14. Reply delay jitter - a 0.01 microsecond maximum peak-to-peak over the dynamic sensitivity range.

4.8.3.5.3.15. Transmitter duty cycle - a 0.0026 minimum under all operating conditions.

4.8.3.5.3.16. Random triggering - five pps maximum generated under all interrogated and noninterrogated operating conditions.

4.8.3.5.3.17. Transponder recovery time - fifty microseconds maximum for signal levels differing as much as 65 dB. Recovers to full sensitivity with no change in reply power, frequency, or pulse characteristics.

4.8.3.5.3.18. Reply lock-out protection - inhibits reply during transponder recovery period.

4.8.3.5.3.19. Over-interrogation protection - restricts response to duty cycle limitations and recover to normal operation 500 microseconds maximum after interrogation PRF falls to, or below, the maximum specified value.

4.8.3.6. Power supply:

4.8.3.6.1. The airborne battery and battery control shall be independent from other systems in the missile.

4.8.3.6.2. Batteries shall be of sufficient capacity to provide adequate life for load and activation tests, airborne powered transponder evaluation tests, and necessary hold time reserve so that at launch, sufficient battery life remains for powered flight plus 10 percent of the rated battery ampere hour capacity (paragraph 4.3.6.2).

4.8.3.7. Ground system:

4.8.3.7.1. Test equipment:

4.8.3.7.1.1. The use of unique, nonstandard, and unduly complex test equipment is discouraged.

4.8.3.7.1.2. Range users may provide a test station to be operated by their contractor. If provided, the test station must have the capability of determining the transponder performance characteristics required by WSMC Form 89.

4.8.3.7.2. Launch facility - the design of the RF repeater system(s) used in silo type or inaccessible launch facilities must provide a means for direct coupling of the transponder test station into the RF repeater system(s).

4.8.3.7.3. Control console - provisions shall be made by the Range user to provide the following transponder controls and monitors to the launch control center Range missile control representative console.

4.8.3.7.3.1. Transponder system power monitors (on-off, external-internal).

4.8.3.7.3.2. Controls for transponder system operation (on-off, external and internal power mode).

4.8.3.7.3.3. Sensors to monitor transponder applied voltage. Voltmeters for this purpose are preferred; however, the option exists to provide either voltmeters or voltage comparator circuits with status lights.

4.8.3.7.3.4. Ammeter to monitor quiescent and transponding mode currents.

4.8.3.7.3.5. Provisions for monitoring battery life or operating time.

4.8.3.7.3.6. In addition, other monitors or controls may be required depending on the nature of the system and individual system components. If required, the additional monitors and controls are identified at the design review.

4..8.3.7.3.7. In all cases, the provided monitors must be continuously available or available on demand to the RMCR.

4.8.4. The tracking beacon and transponder systems must be, by their very nature, of the highest reliability. This high reliability is ensured by placing the appropriate design and testing requirements on the individual components and on the system comprised of these components. Such reliability can be compromised if the tracking beacon and transponder systems components are not subject to rigorous review and control during the manufacturing process.

4.8.4.1. The electronic-piece parts and materials used in the manufacture of flight termination system components must be of "Space Quality" as defined in MIL-STD-1547 and capable of meeting the general and detailed requirements set forth there.

4.8.4.2. The manufacturers of tracking beacon and transponder systems components must have a quality program to make sure all machining, wiring, batching, shaping, soldering, basic production operations of any type, and processing and fabricating of any type is accomplished under controlled conditions. Controlled conditions include documented work instructions, adequate production equipment, and any special working environment. Documented work instructions are considered to be the criteria for much of the production, processing, and fabrication work. These instructions are the criteria for acceptable or unacceptable workmanship.

4.8.5. Testing requirements:

4.8.5.1. Qualification:

4.8.5.1.1. All components of the tracking beacon and transponder system, and methods of attaching or installing the system, must be tested to make sure of their environmental survivability.

4.8.5.1.2. Tests must be performed to determine the antenna receiving characteristics, to show compliance with 4.3.2 above, and provide the antenna pattern data.

4.8.5.1.3. Transponders that have not previously been certified for use at WSMC must undergo qualification tests according to 4.3.2 above. Further, transponders that have been certified for use at WSMC with a particular vehicle may require additional qualification tests (environmental, survivability, and RFI) if the transponder is to be used with a different type and model launch vehicle. The qualification testing of two transponders may be conducted by an independent agency or by the transponder vendor. The identification of the test agency is determined on a case-by-case basis through joint WSMC and Range user agreement. In addition, certain tests are performed by the WSMC RF Measurements Laboratory according to a test plan developed in joint agreement between WSMC/SEO and the Range user. Further, the tests conducted by the WSMC RF Measurements Laboratory do not include any type of testing that would preclude future use of transponders as flight articles. The Range user is responsible for supplying two transponders as flight articles and two transponders for testing by the WSMC RF Measurements Laboratory.

4.8.5.1.4. Power supply tests and analyses must be performed to determine battery-load life, considering the loads that are imposed during battery activation, load tests, prelaunch tests, countdown, and flight.

4.8.5.1.5. Retesting may be required when modifications or changes are made to the system or components. The requirement for retesting will depend on the extent and type of modifications being made and is determined through joint WSMC and Range user agreement on a case by case basis.

4.8.5.2. Recurring:

4.8.5.2.1. System - an RF open loop tracking system compatibility verification check is conducted as late in the launch countdown as possible. The check results are annotated on WSMC Form 189, Standard Tracking Transponder Evaluation/Compatibility Test. This check is to prove the integrity of both the airborne system and ground system. This verification check is conducted on airborne power and is included in the launch agency countdown. It is valid for a maximum of 12 hours, but must be repeated if, at any time after the test, the system is compromised (for example, disconnection of any portion of the system). Further, if the compatibility verification check is inconclusive, a test may be required using the WSMC portable radar simulator.

4.8.5.2.2. Antenna:

4.8.5.2.2.1. Antenna VSWR and RF line insertion loss tests are conducted on the antenna system for each missile. Any antenna system component or element change subsequent to the test requires retesting prior to launch.

4.8.5.2.2.2. An RF closed loop antenna and transponder system RF sensitivity and operational characteristics test is required at WSMC if any connections in the antenna system, including connection to the transponder, are disconnected after completion of the transponder performance test, after final connection of the antenna system to the transponder.

4.8.5.2.3. Each transponder is performance tested, in the bench test mode, by the WSMC RF Measurement Laboratory or equivalent facility prior to its installation into the launch vehicle. The test is conducted as late in the individual missile system receipt-thru-launch readiness sequence as possible (normally within 90 days of launch, consistent with the time requirements for test result data accumulation). The test is performed according to a plan developed in joint agreement between WSMC/SEO and the Range user. Transponder performance characteristics to be determined (in addition to those required by WSMC Form 89, Standard Tracking Transponder Performance Test) are identified in the joint WSMC and Range user test plan. The transponder must also be performance tested at WSMC prior to launch. The test is performed as late in the individual missile system receipt-thru-launch readiness sequence as possible (normally within 90 days of launch), consistent with the time requirements for test result data submission. The test is conducted in an RF closed loop system mode. The transponder will not be removed from the launch vehicle and instrumentation wafer or disconnected from the missile-borne antenna system. Testing is accomplished in an RF closed loop mode. In the interest of economy and testing standardization, WSMC provides a portable test station to be operated by WSMC RF Measurements Laboratory. However, Range users may provide a test station to be operated by their contractor. Specific requirements applicable to the RF closed loop mode performance test are:

4.8.5.2.3.1. The WSMC RF Measurement Laboratory verifies that the test station is operating within the limits and specifications acceptable to WSMC/SEO. This verification is performed at each six month interval according to a test plan developed in joint agreement between WSMC/SEO and the Range user.

4.8.5.2.3.2. RF loss factors must be provided for the RF cable and antenna couplers.

4.8.5.2.3.3. The test is performed according to a plan developed in joint agreement between WSMC/SEO and the Range user.

4.8.5.2.3.4. The test station must have the capability of determining the transponder performance characteristics required by WSMC Form 89.

4.8.5.3. When requested by the Range user and approved by WSMC/SEO, the transponder is processed in the manner described in 4.5.2.1.1 above with restrictions and controls appropriate to this system. Justification for use of this concept, and the detailed procedures for implementing it, requires a joint WSMC/SEO and Range user documented agreement indicating joint approval.

4.8.5.4. The battery test requirements detailed in 4.8.5.1 above apply to tracking beacon and transponder systems.

4.8.5.5. The ground system test requirements detailed in 4.5.2.5 above apply to tracking beacon and transponder systems.

4.8.6. A representative of WSMC/SEO will attend certain system and component level tracking beacon and transponder system tests and installation functions. For preliminary planning purposes, the general group of tests and installation functions that may require attendance are listed below. This listing is not all inclusive and may have items deleted or added, depending on the type and nature of missile system, launch facility, and tracking beacon and transponder system. For complete clarification, the firm requirements applicable to each missile system program shall be specified by separate correspondence to each Range user.

4.8.6.1. Transponder performance test conducted at WSMC.

4.8.6.2. Antenna system VSWR and RF insertion loss test (if conducted at WSMC).

4.8.6.3. RF closed loop antenna transponder system RF sensitivity and operational characteristics test.

4.8.6.4. Battery load and activation test.

4.8.6.5. Tracking beacon and transponder system installation inspection.

4.8.6.6. Tracking beacon and transponder system associated ground system test.

4.8.6.7. Preliminary tracking beacon and transponder system RF open loop compatibility verification check. This is not a WSMC/SEO required test. However, the range user normally conducts several of this type check during the missile receipt-thru-launch process for the purpose of detecting and resolving any problem areas prior to the launch countdown test.

4.8.6.8. Launch countdown tracking beacon and transponder system RF open loop compatibility verification check.

4.8.7. Data requirements:

4.8.7.1. Initial - the following data must be submitted in support of a tracking beacon and transponder system proposal. All schematics, functional diagrams, and operational manuals must have well defined, or standard IEEE, or MIL-SPEC terminology and symbols.

4.8.7.1.1. Design:

4.8.7.1.1.1. System:

4.8.7.1.1.1.1. A block diagram of the entire system with reference to the location in the vehicle of each component and element.

4.8.7.1.1.1.2. Detailed schematics and functional diagrams of the system, including all power sources, relays, switching devices, connectors, and pin numbers showing manufacturer specifications and tolerances.

4.8.7.1.1.1.3. Detailed functional description of the operation of each component and of the system.

4.8.7.1.1.2. Antenna - a detailed description of the antenna system with the specification and operation manuals, as appropriate.

4.8.7.1.1.3. Transponder - copies of the specification and operation manuals.

4.8.7.1.1.4. Power supply - copies of the airborne battery specification and operation manuals.

4.8.7.1.1.5. Ground system:

4.8.7.1.1.5.1. Launch facility - a description of the RF repeater system.

4.8.7.1.1.5.2. Test equipment:

4.8.7.1.1.5.2.1. A complete listing and description of all test equipment, including contractor-peculiar test equipment used to checkout the system and its individual components and elements.

4.8.7.1.1.5.2.2. Copies of all specification and operation manuals for all contractor-peculiar test equipment used to checkout the system and its individual components and elements.

4.8.7.1.1.5.3. Control console - a complete description of the operation of the tracking beacon and transponder system controls and monitors.

4.8.7.1.2. Qualification test procedure - copies of the qualification test plans and procedures required for submission to WSMC, identified by the WSMC/SEO representative during the system design period.

4.8.7.1.3. Qualification test results - pertinent portions of the test result data may be extracted from the test reports and submitted in a condensed form.

4.8.7.1.3.1. Environmental survivability - test result data and information to show compliance with 4.8.3.2 above.

4.8.7.1.3.2. Antenna - the antenna patterns and information according to the requirements of 4.8.5.1.2 above. The antenna patterns must be provided both on magnetic tape and in graphical representation.

4.8.7.1.3.3. Transponder - the results of qualification tests, 4.8.5.1.3 above.

4.8.7.1.3.4. Power supply - battery load test analysis, 4.8.5.1.4 above, to show compliance with 4.8.3.6.2 above.

4.8.7.1.4. Recurring test procedure:

4.8.7.1.4.1. The procedure for the system compatibility verification check, 4.8.5.2.1 above. This procedure is limited to the steps involved with controlling and monitoring the airborne system 4.8.3.7.3 above. Standard WSMC Radar Compatibility Test Operational Procedure No. 0-0230175A007 is utilized by the radar system.

4.8.7.1.4.2. Antenna:

4.8.7.1.4.2.1. Detailed procedure for the antenna VSWR and RF line insertion loss tests, 4.8.5.2.2.1 above.

4.8.7.1.4.2.2. Detailed procedure for the antenna and transponder system sensitivity and operational characteristics test, 4.8.5.2.2.2 above.

4.8.7.1.4.3. Transponder:

4.8.7.1.4.3.1. Detailed procedure for the bench test mode performance test, 4.8.5.2.3 above.

4.8.7.1.4.3.2. Detailed procedure for the RF closed loop mode performance test if the test is to be performed by the Range user, or the contractor, 4.8.5.2.3.1 and 4.8.5.3 above.

4.8.7.1.4.4. Power supply - detailed procedures for the battery test (paragraph 4.8.5.1.4).

4.8.7.1.4.5. Ground system:

4.8.7.1.4.5.1. Test equipment - detailed procedure for calibration of test equipment (paragraph 4.5.2.5.1).

4.8.7.1.4.5.2. Control console - detailed procedure for calibration of the console (paragraph 4.5.2.5.1).

4.8.7.1.5. All preliminary system proposal data, in whole or in part, should be submitted to WSMC/SEG, informally, as soon as available. The final (critical) system proposal data submission must be a formal report included as a portion of the FTSR (paragraph 4.7.1.6). Ideally, the tracking beacon and transponder system data should be provided as a volume of the FTSR, separate from the volume containing the data on that portion of the flight termination control system that provides for termination of missile flight. Data submittal items that cannot be included in that document, because of size or configuration (such as procedures, component operation and specification manuals, and magnetic tapes), are referenced and submitted as an attachment. All data submission in support of modification or changes to either the preliminary or final proposal must be titled and formatted similarly to the original. The document is prepared using the following format:

4.8.7.1.5.1. Introduction - outlines the contents of the report and also includes any deviation to the document agreed to during the design period (paragraph 4.2.1).

4.8.7.1.5.2. General system description - a brief general description and block diagram of the tracking beacon and transponder system, 4.8.7.1.1.1.1 above.

4.8.7.1.5.3. Detailed system description - design data specified in 4.8.7.1.1.1.2, 4.8.7.1.1.1.3, 4.8.7.1.1.2, 4.8.7.1.1.3, 4.8.7.1.1.4, and 4.8.7.1.1.5 above.

4.8.7.1.5.4. System qualification testing - system qualification test data specified in 4.8.7.1.2 and 4.8.7.1.3 above.

4.8.7.1.5.5. System recurring test procedures - system recurring test procedures specified in 4.8.7.1.4.1 thru 4.8.7.1.4.5 above.

4.8.7.1.5.6. Other comments or information - the title and information of this section is left to the discretion of the WSMC user or the contractor, but should include those

items not covered in previous sections that are pertinent to the system, launch, or complex being used. As an example, such information normally involves data concerning the ground support equipment.

4.8.7.2. Recurring:

4.8.7.2.1. Test result - the following data, relative to the specific system for each individual launch, must be submitted to WSMC/SEO on a timely basis to facilitate a launch ready status.

4.8.7.2.1.1. Antenna:

4.8.7.2.1.1.1. Results of the VSWR and RF line insertion loss tests, 4.8.5.2.2.1 above.

4.8.7.2.1.1.2. Results of the antenna and transponder system RF sensitivity and operational characteristics test, if applicable, 4.8.5.2.2.2 above.

4.8.7.2.1.2. Transponder:

4.8.7.2.1.2.1. Results of the transponder vendor acceptance test.

4.8.7.2.1.2.2. Results of the transponder bench test mode performance test, 4.8.5.2.3 above.

4.8.7.2.1.2.3. Results of the transponder RF closed loop mode performance test, if conducted by the Range user or the contractor, 4.8.5.2.3.1.2 above. Results of this test must be annotated on WSMC Form 89. Transponder performance characteristic data from this test are distributed to the WSMC tracking radars. To permit a timely dissemination of this data, WSMC Form 89 should be provided to WSMC/SEO no later than 18 working days prior to the forecast launch date.

4.8.7.2.1.3. Power supply - results of the battery load and activation test, 4.8.5.1.4 above.

4.8.7.2.1.4. Ground system - data relative to calibration of the ground system must be provided to WSMC/SEO according to the specified calibration time schedule.

4.8.7.2.1.5. Components or system failure - the requirement for reporting failure of a component or system to meet the requirements of a specific test applies to tracking beacon and transponder system.

4.9. Telemetry systems:

4.9.1. Telemetered data, particularly data concerning the status of the flight termination system components and of missile and launch vehicle performance, form an integral part of the missile flight control system. Because of this, certain components of the telemetry system are considered to be an integral part of the flight termination control system. As such, these components and subsystems are subject to the same level of scrutiny as other portions of the system. The determination of which portions of the telemetry system will be subject to this scrutiny is made on a program-by-program basis as early in the program as is feasible. Also at this time, the specifics of this scrutiny are detailed, including data requirements, participation during the design period, test requirements, and test attendance.

4.10. Additional information - detailed data in the operational parameters of instrumentation facilities to be employed by WSMC in support of a particular program are available from WSMC. Other sources of information that may be useful in preparing data required by this section are listed in attachment 2.

CHAPTER 5

SPACE AND MISSILE SYSTEMS GROUND OPERATIONS

5.1. Space and Missile Systems Ground Operations Introduction. This chapter presents WSMC/SE requirements that apply to all space and missile systems ground operations conducted under WSMC jurisdiction at Vandenberg AFB.

5.2. Safety Responsibilities:

5.2.1. WSMC/SE is responsible for developing and managing the Commander's Safety Program (paragraph 1.3). WSMC/SEM provides launch complex safety management, performs safety surveillance and support of hazardous and dangerous operations (certain areas covered by AFR 207-24, (S) System Security Standard - Space Launch Complexes (U) are excepted), and assists the 6595th Group Commanders and their respective command elements in identifying and resolving space and missile safety problems. The 6595th Group Commanders (6595 ATG, MTG, STG) are responsible for the implementation of space and missile systems ground safety programs during all prelaunch, launch, and recovery or landing operations.

5.2.2. A safety hold is a directive (usually verbal) to either prevent an operation from starting (NO-GO) or stopping an operation that is already underway. Typical reasons for a safety hold are:

5.2.2.1. Safety criteria cannot be assured or maintained.

5.2.2.2. Safety criteria is being violated.

5.2.2.3. Personnel or equipment is, or will be, unduly jeopardized.

5.2.3. Persons authorized to call a safety hold are:

5.2.3.1. The person in charge of an operation (launch control officer (LCO), task supervisor, or test conductor) is authorized and required to place an operation in a safety hold if safety criteria are being violated or personnel and equipment are being unduly jeopardized. Operations placed in a safety hold must not be resumed until the discrepancy has been corrected.

5.2.3.2. The Complex Safety Officer (CSO), or, in his absence, the LCO, provides authoritative safety surveillance of hazardous operations and aids in resolving safety problems. When, in the judgment of the CSO, an operation being monitored is dangerous to life or property, the CSO advises the LCO, task supervisor, test conductor, or other person in command of the operation, and imposes the requirement for a safety hold or "NO-GO." The person in command of the operation will give the command to cease the operation at the first safe point in consonance with the technical data governing the operation. If time does not permit communication with the task supervisor, the CSO transmits the hold directly to the person performing the task.

5.2.3.3. When a person in command (launch controller, task supervisor, etc.) is not immediately available, the CSO or Complex Safety Technician (CST) issues an immediate safety hold order to stop an unsafe operation. The operation must not be resumed until the discrepancy is resolved.

5.2.3.4. Personnel not specifically designated as task supervisors or qualified as CSOs and CSTs, who observe any of the above conditions that would warrant a safety hold

decision, are responsible for bringing such conditions to the immediate attention of the responsible task supervisor and taking whatever immediate action is warranted to safeguard life and property.

NOTE: When an unsafe condition is noted and a safety hold is declared, the operation ceases at the first safe hold point in consonance with the technical data governing the operation. The person calling the hold immediately notifies all agencies it may affect.

5.3. Launch Complex Safety Plan (LCSP). The LCSP is required for each launch complex or major system complex such as Titan, Minuteman, Atlas, Peacekeeper, and Space Transportation Systems. The appropriate group commander is responsible for making sure the LCSP is published and kept current. If appropriate, it also covers associated support facilities elsewhere on base. It is a comprehensive document intended to clarify or detail existing broad safety rules and to provide needed rules, not published elsewhere, for all personnel at the facility. The LCSP shall be approved by WSMC/SE and must, as a minimum, include:

5.3.1. A list of all operations at the facility defined as hazardous or dangerous according to this regulation and 1 STRADR 127-200, Missile Mishap Prevention.

5.3.2. A list of all hazards present at the facility and any special rules or precautions required for each.

5.3.3. Detailed procedures for implementing the requirements for initial safety training of personnel, annual recurring training, and documentation. Include such subjects as hazard recognition, buddy system requirements, checklists, safety equipment, monitoring and warning devices, and emergency evacuation procedures.

5.3.4. A program to ensure that appropriate personnel are trained in the approved methods of cardiopulmonary resuscitation and first-aid procedures, and that required documentation is recorded (paragraph 5.6.6.7).

5.3.5. Visitor safety briefings, when required, and who will present them.

5.3.6. Complete explanation of all aural-visual hazard warning systems, their operation, and response requirements.

5.3.7. Emergency evacuation routes from all locations, including notification and control of THC.

5.3.8. Mishap reporting and emergency response phone numbers. Include immediate notification to the CSO and CST of any equipment and property damage or personnel injury.

5.3.9. Self-inspection program.

5.3.10. Any safety checklists not otherwise provided in individual test and operations procedures.

5.3.11. Ground processing by Range users must be performed only by persons certified in the disciplines required for those processes. Range users provide a description of their certification and training program in the facility and complex safety plan. The description specifies the personnel training required and the certification procedures employed to establish acceptable skill levels for those involved in hazardous and dangerous operations.

5.3.12. A list and description of approved protective clothing, breathing apparatus, and associated personal protective devices and their required use. Specifically include hard hats, areas of use or wear, and approved types and color coding.

5.3.13. Detailed procedures for reaction to electrical storm warnings, high winds, etc.

5.3.14. Detailed facility reaction procedures for general emergencies (such as fires, explosion, or propellant spills).

5.3.15. Amplification of "No Smoking" rules for high hazard areas such as propellant or explosive locations, posting of warning signs, and positive rules requiring that matches and lighters be left outside the areas. Eating and drinking is prohibited in areas where toxic or nuclear materials are being handled or processed.

5.3.16. General locations of fire alarm boxes, installed fire suppressant systems, and appropriate information regarding use.

5.3.17. Location of emergency rescue equipment, medical and first-aid rooms.

5.3.18. A description of potential hazards to the facilities and personnel that are not a part of the facility or systems (such as motor vehicles or equipment with internal combustion engines).

5.3.19. A safety badge (permit) system detailing temporary, visitor, permanent, and indefinite requirements (approved by WSMC/SE), shall be established for each missile system or complex. Procedures identifying detailed requirements for each type of badge or permit are included. (WSMC/SE retains the option to train and certify Safety and other WSMC personnel, as required, on each missile system or complex.) Range users will furnish WSMC/SE updated listings of permit numbers, names, and assigned agencies prior to all launches.

5.3.20. Use of vehicles:

5.3.20.1. Vehicles must not be parked within 25 feet of propellant lines containing propellants. Vehicles may proceed within the 25-foot limit when required to deliver heavy equipment. After offloading, the vehicle shall be removed.

5.3.20.2. Vehicles must not be parked within 50 feet of propellant storage tanks containing propellants. Vehicles may proceed within the 50-foot limit to deliver heavy equipment, or tractors may deliver or pick-up tankers and servicing units. After offloading of equipment, vehicles shall be removed. Tractors remaining with tankers must follow the requirements of the loading and offloading Hazardous Operating Procedure (HOP).

5.3.20.3. Motor vehicles or equipment employing internal combustion engines equipped with or without catalytic converters, require spark arrestors and carburetor flame arrestors when:

5.3.20.3.1. Transporting explosives that have exposed grain, scrap, waste, or items visibly contaminated with explosives.

5.3.20.3.2. Operating internal combustion engines within the control area during propellant transfer.

5.3.20.4. Mobile radio transmitters must not be operated within 25 feet of ordnance or (unless intrinsically safe) within 50 feet of fueling operations.

5.4. Hazardous and Dangerous Operations. These operations have systems with high energy potentials or toxic properties requiring special measures be taken to limit risk to personnel or property. Work involving ordnance materials, missile fuels and oxidizers, cryogenics, high pressures, lasers, high energy RF emissions, and radioactive components are examples. Specific actions are required for all hazardous and dangerous

operations involving, as a minimum, activation of a safety control area, display of amber or red warning lights, and use of an approved procedure or checklist. The latter requirements are fulfilled by the inclusion of special safety procedures in the approved written document for the work involved.

NOTE: Pad status lights, amber and red, are used only during the time hazardous operations are in progress and will not be used to identify loaded tanks, missiles, or facilities when in a static mode. Exceptions require specific WSMC/SE approval.

5.4.1. For hazardous-dangerous operations safety support, the Range user will notify WSMC/SE of the time and nature of all hazardous and dangerous operations through normal scheduling channels. WSMC/SE personnel will not be denied access to any area where such operations are conducted. WSMC complex safety representatives provide mandatory safety support and surveillance of certain operations, so identified by WSMC/SE, and periodically check all other hazardous operations to evaluate safety compliance by the user. The presence of WSMC/SE representatives is required for all launch operations, most dangerous operations, and selected hazardous operations. When safety support is listed as mandatory, the operations will not be started until the required support is present.

5.4.2. Operations identified as hazardous or dangerous must be scheduled to ensure that WSMC/SE and Base agencies such as Fire Department and Security Police are notified. Scheduling is done by utilizing the 1 STRAD Form 36, Missile Operations Support Requirements, (MOSR), according to 1 STRADR 80-1, ICBM Operational Test and Evaluation (FOUO), and 1 STRADR 127-200. Safety, fire, security, and medical personnel and equipment determined necessary must be approved by WSMC/SE prior to final coordination of MOSR requests.

5.4.3. All hazardous and dangerous operations, including launches conducted at WSMC and associated with missile and space vehicle operations and their support, shall be covered by WSMC/SE approved operating procedures. Special test operation procedures that may not meet the criteria for hazardous or dangerous operations, but have a safety requirement for protective clothing, safety equipment, or safety control areas will be approved by WSMC/SE. Procedures and countdown manuals are developed by the agency responsible for performing the work. The user is responsible for submitting these procedures, in duplicate, to WSMC/SE for review and approval 30 days prior to the need date. The user reviews and approves the procedures prior to submitting them to WSMC/SE. All signature blocks are signed prior to submittal of the procedure or countdown manuals. Draft or preliminary copies may be sent to WSMC/SE for preliminary comments without previous review or approval of the user. This technique of simultaneous review is encouraged. Changes to approved or redlined procedures must meet all requirements of new procedures. (Exception: Redline changes to procedures in progress shall be approved by the CSO on site.)

5.4.3.1. Deviation from an approved HOP is not allowed without the specific approval of WSMC/SE.

5.4.3.2. Hazardous operating procedures shall be written in the clearest, most logical, and precise terms to make sure personnel concerned with performing the task understand the steps to be performed. Sequential, step-by-step directions are written in clear language and with sufficient detail to allow a qualified technician, mechanic, or operator to follow them easily. Emergency shutdown or backout procedures are normally included but may not be required if adequately provided for in the complex safety plan. Excessive use of second tier reference to other directives is not acceptable.

5.4.3.3. The following information must be included in all HOPs (the format, however, is not compulsory):

5.4.3.3.1. Title (cover page with required approval signatures, date, and annotation that procedure is "Hazardous").

5.4.3.3.2. Purpose should describe briefly what task, operation, test, or checkout is to be accomplished.

5.4.3.3.3. Each hazardous step or instruction is immediately prefaced in bold type with the attention word "WARNING," "CAUTION," OR "NOTE," according to the following criteria:

5.4.3.3.3.1. WARNING - operating procedure that must be strictly complied with or personnel injury or loss of life may result.

5.4.3.3.3.2. CAUTION - operating procedure that must be strictly complied with or equipment damage may result.

5.4.3.3.3.3. NOTE - operating procedure of such importance that it must be emphasized.

5.4.3.3.4. Specific warnings, cautions, or notes appear immediately preceding the hazardous step. Identify the end of the hazardous step(s). General caution and warning note prerequisites should be included in the preface. In addition, the hazardous configuration of the vehicle, system, and subsystem prior to the start, and after completion, of the operation should be defined.

5.4.3.3.5. A list of tools, personal protective safety equipment, and other test support equipment for the job and, where required, WSMC/SE approved equipment such as Alinco Meters. Specify required monitoring devices.

5.4.3.3.6. Appropriate safety highlights such as evacuation, safety clearance to proceed, etc., must be detailed in the proper place in the procedure.

5.4.3.3.7. A list of essential personnel, by job title (function and number), is required for all hazardous and dangerous operations. WSMC Form 33, Safety Access List, will be completed for all safety control areas established by WSMC/SE whenever approved contractor access lists are not available and provided to SE.

5.5. Complex Safety Officer's Console:

5.5.1. Sufficient space must be provided in an appropriate location to install and operate a pad safety console in each launch control center, block house, firing room, and other similar facilities. The console will be provided by the range user. WSMC/SE will approve the design of the console. Minimum requirements for the console must incorporate:

5.5.1.1. Countdown nets capable of monitoring and transmitting.

5.5.1.2. Direct line(s) to the test conductor and LCO.

5.5.1.3. A direct line to the MFCO.

5.5.1.4. Direct lines to the Launch Support Team Chief and fallback area.

5.5.1.5. Direct lines to primary access control point for safety control areas.

5.5.1.6. Direct lines to facility safety net.

5.5.1.7. Access to the facility PA systems with emergency override capability.

5.5.1.8. At least one class A dial line.

5.5.1.9. A direct line to the Range Control Officer (RCO).

5.5.1.10. Direct line to hospital emergency room.

5.5.1.11. RF nets, as required, by specific MSGSA.

5.5.2. Console shall be located with clear view of appropriate blockhouse and control center TV monitors, with control of one or more TV cameras for primary safety use.

5.5.3. Controls one or more TV monitors to enable CSO surveillance of specific areas. (To be defined in individual system MSGSA.) Video taping of specific hazardous operations will be coordinated, as required, with the launch controller or test conductor prior to the start of the operation.

5.5.4. Controls for facility aural and visual warning system, that is, switch selection of Green, Amber, and Red warning lights with separate control of klaxon or siren.

5.5.5. Wind speed and direction readouts.

5.5.6. Complex and Range clearance lights to MFCO.

5.5.7. The range user will provide the capability for communication and video recording and playback of hazardous operations as designated by the CSO. Designated recordings will remain on file for 180 days.

5.6. General Operating Rules and Requirements:

5.6.1. General safety requirements cited in this section shall be included in all applicable hazardous procedures or operations safety checklists.

5.6.1.1. Verify that all installed and portable required safety systems and equipment are operational before operations are permitted to begin.

5.6.1.2. Any operation involving propellant transfer or ordnance activities must not begin when an electrical storm is imminent. Such operations shall be interrupted or expeditiously concluded if an electrical storm approaches within a 10-mile radius.

5.6.1.3. Delays or lengthy interruptions during hazardous operations are not conducive to good safety practices. Test conductors or task supervisors should consider rescheduling the operation or establishing safety hold points to determine personnel fatigue and expiration of crew time prior to continuing. Personnel participating in missile operations are normally scheduled to work only eight hours commencing when the individual reports for duty. When justified by mission requirements, the duty hours may be extended to 12 hours. If a need exists to exceed the 12-hour limit, the applicable unit test conductor or task supervisor, after a complete evaluation of the hazards and risks involved in continuing the task, is authorized to extend total crew time, not to exceed 14 hours, after coordination and approval of WSMC/SE. In no circumstance should a task or operation be started that will exceed the 12 hour crew time restriction. Any delay interrupting ordnance or propellant operations must be coordinated with WSMC/SE.

5.6.1.4. Normally, simultaneous hazardous operations conducted in adjacent areas will not be approved ("adjacent" means side by side, in the same complex or building, or in close enough proximity to affect the other hazardous operations). When it is necessary to schedule simultaneous hazardous operations in order to meet a critical program milestone, approval must be obtained from WSMC/SE on an individual basis.

5.6.1.5. Nonessential personnel must leave the hazardous area any time a safety control area is in effect. Visitor requests into the safety control area must be coordinated with WSMC/SE (CSO/CST).

5.6.1.6. Essential personnel may continue working within the safety control zone during a hazardous operation, but must evacuate the safety control zone during a dangerous operation. Hazardous and dangerous operations must be identified in the appropriate procedure.

5.6.2. Propellant systems:

5.6.2.1. Personal protective equipment for operations involving propellants are listed in AFM 161-30, volumes I and II, and AFOSH standards. Protective equipment or clothing must be approved by WSMC/SE prior to use.

5.6.2.2. Written procedures for propellant operations must clearly specify those times and circumstances when personal protective clothing and breathing equipment must be worn, carried, or positioned within arm's reach.

5.6.2.3. When work is to be performed in a known, or suspected, oxygen deficient or contaminated environment, self-contained and supplied air breathing equipment must be worn. Atmospheric or gas detection and measurement devices shall be used to determine atmosphere content before entry. (A suspect environment may result from other circumstances than toxic fuel involvement, such as gaseous nitrogen, fire, etc.)

5.6.2.4. When establishing initial leak free flow of toxic propellants during ready storage vessels (RSV) onload and offload from tanker trucks and during propellant transfer, personnel directly involved in the operation must be fully dressed in approved protective clothing such as SCAPE, RFHCO, or SPLASH, and have appropriate breathing apparatus readily available for immediate use, or worn as the written procedures for the particular task may require.

5.6.2.5. Propellant system components such as valves, regulators, orifices, flowmeters, etc., inherently entrap propellants to some degree. Disassembly of these components can cause serious injury to personnel not made aware of the possible presence of dangerous propellants. Tagging of removed or disassembled components contaminated by propellants and their transportation will be according to TO 00-25-223 and applicable AFOSH directives.

5.6.2.6. HOPs covering hypergolic propellant transfer and handling will reflect the necessity for preventing the fuel and oxidizer, in liquid or vaporous states, from coming in contact with each other.

5.6.2.7. Simultaneous tanking of fuels and oxidizers aboard a missile is permitted only on systems that are remotely controlled and when all personnel are clear of the danger area. Each system is independently leak-checked prior to propellant flow. Simultaneous tanking must be approved by WSMC/SE.

5.6.2.8. Tanking of toxic or cryogenic liquids aboard a missile is performed as late in the countdown as practical. Reentry into the area that has a missile with fuel and oxidizer aboard must be held to a minimum and subject to WSMC/SE approval.

5.6.2.9. Minor leaks or spills are those that only affect the immediate working area, present little or no hazard to personnel, and do not involve damage to facilities or equipment. These are washed and flushed with water into collecting tanks or holding basins if necessary. The propellant must not be flushed to surrounding ground surface if ecological or health hazards are involved. Disposal procedures for the latter must be approved by the Bioenvironmental Engineering Services at VAFB.

5.6.2.10. Major spills and leaks are those that could affect regions beyond the immediate work area, constitute a significant hazard to personnel in the adjacent work areas or distant downwind areas, or involve damage to facilities or equipment. Written propellant handling procedures or plans must at least provide for:

5.6.2.10.1. Shutting off the source of the propellant.

5.6.2.10.2. Rescue of injured or trapped personnel.

5.6.2.10.3. Notifying emergency reaction agencies such as fire department, complex safety, hospital, security police, and bioenvironmental services.

5.6.2.10.4. Immediately notifying all areas, nearby and distant, where people are present and may be subject to exposure of toxic material. This normally means all locations in the predicted THC for the subject area.

5.6.2.10.5. Evacuation of the area.

5.6.2.11. Spills of cryogenic liquids must be flushed with large amounts of water, as appropriate, into the surrounding ground surface or a holding basin. Spills of toxic or corrosive propellants, or those that could affect the public health or ecology, are normally flushed with water, or another neutralizing agent, into a collecting tank to be disposed of by approved procedures.

5.6.2.12. Written procedures must include immediate emergency action, such as: skin or eye contact with toxic propellants must be flushed with copious amounts of water for a minimum of 15 minutes. Exposed persons are taken to the nearest medical facility immediately after the minimum water flushing treatment has been given, unless a qualified medical technician or doctor directs other action.

5.6.2.13. HOPs will reflect meteorological limitations for use by all agencies in scheduling and conducting toxic propellant operations such as loading, sampling, conditioning, etc. Precautions shall be taken to protect all personnel and property from atmospheric concentrations of toxic materials that exceed the threshold limit value. The supervisor responsible for the transfer and handling operation is responsible for obtaining the predicted THC and determining that conditions meet the limitations shown in the HOP approved by WSMC/SE. Venting of toxic vapors requires WSMC/SE approval.

5.6.2.14. HOPs for handling of toxic propellants and materials must include as a minimum:

5.6.2.14.1. Type, location, and use of monitoring devices.

5.6.2.14.2. Type, make, and location of breathing apparatus, protective clothing, and special handling equipment.

5.6.2.14.3. Task number and points within tasks when a release of toxic material would most likely occur.

5.6.2.14.4. Specific THC required for each propellant task or operation.

5.6.3. For photographic operational constraints, the use of photographic lighting equipment (flashbulbs, strobe lights, photofloods) is prohibited within 100 feet of the missile whenever the missile is fueled, and within 100 feet of a propellant storage tank; also, within 10 feet of exposed solid propellants and ordnance, or other explosive

hazardous environments. Any exception to these restrictions requires approval by WSMC/SE on an individual basis depending on the type of photographic equipment to be used and the nature of the subject to be photographed.

5.6.4. All ordnance items used at WSMC will be handled according to the procedures contained in AFR 127-100, AFOSH standards, VAFBR 136-1, Storage, Handling, and Inspection of Contractor and Tenant Explosives on VAFB, 1 STRADR 127-200, and appropriate technical orders. HOPs must include specific safety precautions and information such as grounding requirements, essential personnel, required tools, and electrical checkout equipment. Protective equipment for ordnance operations must be approved by WSMC/SE prior to use.

5.6.4.1. Category A ordnance installation or removal and electrical connection or disconnection will be designated as hazardous operations.

5.6.4.2. Established written procedures shall include any necessary precautions for protection of ordnance items against inadvertent activation caused by RF energy. This includes provisions to make sure any transmitters within hazardous range do not radiate during the ordnance operation.

5.6.4.3. Written procedures must specify that all ordnance circuit control switches and firing line interrupt switches should be in the off position for electrical connection of ordnance and must remain off except when otherwise provided in approved procedures.

5.6.4.4. Leg or wrist stats must be used by personnel handling ordnance with shorting caps removed (during connect or disconnect). The objective is to provide a positive bond between person, ordnance item, and facility ground. When conductive floors and shoes are to be used in lieu of wrist stats, written application must be made to WSMC/SE for deviation from this requirement and special provisions must be followed.

5.6.4.5. When approved, conductive floors, grounding mats, or grounding terminals must have the same potential as the system employing the EED. This is accomplished by the use of an electrical bond.

5.6.4.6. When hoisting ordnance with a crane, the methods of paragraph 3.14.7.1 will be utilized.

5.6.4.7. During any operation involving exposed solid propellant grains, leg or wrist stats are mandatory. Leg or wrist stats should be designed so the wire strap can be disconnected easily from both the wrist or leg strap and the grounding terminal. A method for continuity checks must be available.

5.6.4.8. Preinstallation electrical checkouts of any ordnance items will be performed in facilities or test cells approved by WSMC/SE.

5.6.4.9. Command destruct receivers will only be turned on during scheduled operations with approved procedures, after ordnance of the flight termination system has been electrically connected.

5.6.5. For pressure systems, safe operating procedures will be prepared governing the operation, testing, maintenance, and installation by the agency performing the specific task. The criteria contained in AFR 127-101, Ground Accident Prevention Handbook, AFOSH standards, TO 00-25-223, and 1 STRADR 127-200 will be used in the design and testing and in developing safety operating procedures.

5.6.5.1. Each complete system must be pressure tested and leak-checked at its maximum operating pressure at least once and pressure relief valves operationally tested at 10 percent above the maximum operating pressure prior to use in normal operations at WSMC. The same requirements apply for modified or repaired components.

5.6.5.2. New, modified, or repaired systems and subsystems must be functionally validated prior to acceptance for normal operational use. The user will certify that validation tests were successfully completed and the system and subsystem are certified for use.

5.6.5.3. Functional tests up to maximum operating pressure are required each time a component, such as a valve or regulator, is disassembled for repair, modification, or replacement of soft goods (valve seats) and reassembled for use.

5.6.5.4. Operating procedures involving high pressure must include:

5.6.5.4.1. Posting of warning signs with hazards identified.

5.6.5.4.2. Establishing safety control areas.

5.6.5.4.3. Inspecting system before pressurizing.

5.6.5.4.4. Personal protection equipment requirements.

5.6.5.5. Personnel present during pressurization must be limited to those in direct support of the operation or in a training status.

5.6.5.6. All personnel shall be evacuated whenever pressure exceeds the maximum allowable working pressure or 50 percent of the design burst pressure, whichever is lower.

5.6.5.7. Only essential personnel shall be exposed to pressures between 25 and 50 percent of the design burst pressure of a system.

5.6.6. Electrical systems:

5.6.6.1. Electrical and static ground points are tested and checked periodically according to AFR 127-100, AFR 127-101, Ground Accident Prevention Handbook, and AFOSH standards, or WSMC/SE determines the requirements if specific criteria is not available.

5.6.6.2. Electromagnetic impulse (EMI) testing is not conducted with live EEDs installed without approval of WSMC/SE.

5.6.6.3. Hazardous operating procedures shall be written to cover hazardous electrical tasks. WSMC requires that AF Pamphlet 85-1, Electrical Facilities Safe Practices Handbook, TO 00-25-232, and the National Electrical Code be followed, as applicable. HOPs must address as a minimum:

5.6.6.3.1. Tagging and lockout control switches.

5.6.6.3.2. Use of approved nonconductive mechanical fuse pullers.

5.6.6.3.3. Provision and use of personal protective clothing and equipment.

5.6.6.3.4. Grounding of equipment and personnel.

5.6.6.3.5. Use of "Buddy System" (mandatory on energized equipment and circuits).

5.6.6.3.6. Safety procedures to be followed when working on energized equipment and circuits.

5.6.6.3.7. Fire protection and equipment.

5.6.6.3.8. Knowledge of resuscitation procedures.

5.6.6.4. Special protective equipment must be made available for all operations associated with electrical hazards as specified in directives listed in 5.6.6.3 above. This equipment is inspected periodically and maintained in serviceable condition.

5.6.6.5. Whenever work is performed on energized electrical equipment or circuits, there must be a minimum of two people present (Buddy System).

5.6.6.6. Personnel working on hazardous circuits must not wear loose clothing, rings, watches, or other metallic objects that can act as conductors of electricity.

5.6.6.7. It is essential that all personnel who perform maintenance or repair of electrical systems be trained in approved cardiopulmonary resuscitation (CPR) methods.

5.6.7. Radio frequency and microwave systems - operations involving RF radiation shall be conducted according to procedures approved by the USAF Hospital Bioenviromental Engineering Services. Copies of all personnel hazard data for electromagnetic radiation (for example, measurements, sitings, areas posted, etc.) are required by Bioenvironmental Health Services as specified in AFOSH 161-9.

5.6.7.1. Access to areas where radiation PELs exceed those stated in AFOSH 161-9 will be controlled. The appropriate power meters and antennas specified in TO 31A-10-4 and AFOSH 161-9 are used for making these power density measurements. Personnel are prohibited from performing work in antenna, waveguide, or feeder horn structures while the equipment is energized if exposure to any part of the body could exceed those levels. For higher levels, specific approval must be obtained from the USAF Hospital, Bioenvironmental Engineering Services, which will make appropriate calculations according to AFOSH 161-9 for time weighted exposures.

5.6.7.2. Care is exercised by all concerned to make sure that personnel are not allowed in the calculated or surveyed energy ranges of operating generators that exceed PELs. Procedures are established to exclude personnel from entering these designated controlled areas while equipment is energized. AF Form 737, Warning RF Radiation Hazard, is posted to warn personnel of RF hazards. X-ray radiation hazard areas within RF generating circuitry are marked with the radiation symbol, and the roentgen output per hour is recorded.

5.6.7.3. The use of RF personal protective suits in areas containing RF radiation in excess of the applicable PELs is not generally considered appropriate and will not be done without specific approval of Air Force Medical Service Center, Surgeon General Radiation Branch (AFMSC/SGPA), Brooks AFB, Texas 78235.

5.6.7.4 All personnel working in areas with equipment capable of producing hazardous levels of RF and microwave radiation must be familiar with the sources and types of radiation, operating procedures, and any precautions that have been recommended in radiation hazard survey reports according to AFOSH 161-9.

5.6.7.5. The Director of Base Medical Services is immediately informed of any suspected overexposure of personnel to RF radiation and is requested to assist in evaluation of the incident and preparation of the investigation report according to AFOSH 161-9.

5.6.7.6. A visual inspection of hazardous areas, prior to operation, shall be accomplished to ensure warning lights are operative, barriers are in place, and restricted areas are clear of personnel.

5.6.7.7. Transmitter and antenna orientation electrical limit switches are checked by system personnel daily, prior to operation, to make sure they are functioning. These checks are performed at low output power.

5.6.8. Radioactive materials and nuclear operations - radioactive materials or assemblies must be handled under the supervision of an Nuclear Regulatory Commision (NRC) licensed individual or a custodian appointed by an NRC licensed contractor. This person is normally called the Radiation Control Officer. Operations are monitored off and on the complexes and are coordinated with WSMC/SE and Bioenvironmental Engineering Services. Procedures are according to VAFBR 161-1.

5.6.8.1. All procedures for handling isotopes require WSMC/SE and Bioenvironmental approval.

5.6.8.2. Unattended radioactive material must be secured to prevent unauthorized access and handling at all times.

5.6.8.3. The launch agency must follow WSMC mishap reporting procedures if radioactive material is spilled, released, or dispersed either by design or accident.

5.6.9. Confined space and tank entry will be according to TO 00-25-235 and other appropriate Air Force publications. All procedures, checklists, and directives are coordinated and approved by WSMC/SE prior to implementation. Written procedures for tank entry shall include instructions on tank purging and decontamination, and use of vapor detector or explosion and oxygen meter, as required. The "Buddy System" and specific requirements for protective clothing, equipment, respiratory devices, communications equipment, and fire precautions must be included in the written procedures. Tank entry is classified as a hazardous operation and is scheduled on a MOSR.

5.6.10. Laser and maser systems:

5.6.10.1. All laser and maser systems and operations must conform to the requirements of AFOSH STD 161-10, paragraph 3.8.

5.6.10.2. The Range user is responsible for compliance with bio-environmental hazard survey recommendations and for establishing safety operating procedures.

5.6.10.3. Bioenvironmental and WSMC/SE approval must be obtained for all laser and maser systems and operations on the Range.

5.6.11. Cranes and lifting devices:

5.6.11.1. New, modified, relocated, or extensively repaired cranes and lifting devices must be validated by functional tests prior to being approved for operational use.

5.6.11.2. All tests conducted at WSMC will be performed using written procedures that include emergency shutdown procedures, safety control areas, warning systems and barriers, task supervisor, and operator responsibilities.

5.6.11.3. Procedures will be submitted to WSMC/SEM for approval at least 30 days prior to date needed.

5.6.11.4. All cranes, hoists, and other lifting equipment used or operated at WSMC for permanent or short-time use, whether DOD-contractor owned, rented, or leased, must be properly inspected, tested, and must show proof of tests according to applicable ANSI B30 series safety codes. (T.O. 36-1-58 will be enforced wherever applicable.) In particular, items covered by 5.6.11.4.1, 5.6.11.4.2, and 5.6.11.6 below, are subject to validation. Additionally, all lifting equipment, slings, and auxillary equipment receives preoperational inspection and periodic testing to make sure of safe conditions and equipment integrity before the equipment is used. Frayed or kinked wire ropes, damaged or missing components, damaged or cracked welds or structural parts, fluid leaks, or evidence of heating must be corrected prior to use. The above requirements also apply to cranes, hoists, or lifting equipment that has been modified or altered, or that has had its support structure modified or altered.

5.6.11.4.1. The ANSI B30 series for lifting equipment are the basic documents for proof-testing requirements and are supplemented by the critical and noncritical load test criteria listed in 5.6.11.5, 5.6.11.6, and 5.6.11.7 below. Maximum safe working loads shall be posted on all lifting and hoisting equipment and fixtures. Weights utilized for load testing must be tagged and adequately marked indicating total weight in pounds (lbs) and owner or agency identificaion number. Reinforcing (rebar) steel will not be used for weight lift points.

5.6.11.4.1.1. A 125 percent (110 for mobile cranes) proof-load test must be conducted. The proof-load must be hoisted, held for a predetermined time, raised again, held, lowered, held again, and then lowered to the ground. See attachment 4 for frequency schedule.

5.6.11.4.1.2. A 100 percent minimum load test (not to exceed 125 percent for overhead cranes or 110 percent for mobile cranes) must be conducted on cranes where the load is hoisted, held for a predetermined time, raised again, exercised through its operational envelope, lowered, held again, and then lowered to the ground. In the event the operational load is less than the rated load, the crane may be qualified to the operational load only. In such cases, the lesser load will be exercised through the crane envelope. Exceptions require case-by-case approval.

5.6.11.4.1.3. A test of mechanical and electrical controls, limit switches, and safety devices must be performed through the complete operational range without a load.

5.6.11.4.2. Magnetic particle or other suitable nondestructive inspections (NDI) must be performed annually on all hooks, shackles or eye bolts, links, and single failure point welds used for lifting critical and high value ordnance items, spacecraft, and missile components. Associated lifting hardware (slings, thimbles, shackles, links, eyebolts, swaged fittings, wire ropes, etc.) other than hooks used for lifting noncritical items, do not need NDI testing, but must comply with the testing, inspection, and maintenance requirements set forth in applicable ANSI B30 series, OSHA, 1910.184, and T.O. 36-1-58, and other appropriate documentation. Exceptions require case-by-case approval.

5.6.11.4.3. In addition to the ANSI definitions, WSMC defines critical loads as including, but not limited to, high-value ordnance or propellant items, missile components, spacecraft, other space hardware, and unique or high value items of missile systems or support and facility equipment.

5.6.11.4.4. Attachment 4 provides the frequency requirements for crane tests and inspections at WSMC. Each crane is assigned a category according to its use and environment, and crane tests are then based on the category assigned, and according to applicable standards. Periodic inspectons must be performed by an appointed or authorized person. Inspection records or copies will be maintained at facilities wherever cranes are installed or maintained.

5.6.11.4.5. Crane and hoist controls, such as pendants, push-button stations, and operator stations, must be configured and identified according to ANSI B30.2, B30.11, B30.16, and Crane Manufacturer's Association of America (CMMA) 70 and 74. For trolley and bridge movement, compass points (north, south, east, and west) are preferred identification for the controls.

5.6.11.4.6. Recognized standards such as CMMA, Material Handling Institute (MHI), ANSI, Society of Automotive Engineers (SAE), in conjunction with AFSC Design Handbook 1-6, System Safety, will be utilized to the maximum extent in design or modification of cranes. Crane design or modification specifications must be submitted to WSMC/SE for coordination and approval. Specification submittals must include statements requiring crane manufacturers to submit certificates of acceptable conformance to the above standards.

5.6.11.4.7. Cranes and hoists must not be derated or rerated without adequate justification and specific approval of WSMC/SE.

5.6.11.4.8. Personnel will not be permitted to work under suspended loads nor will loads be transported over inhabited work stations.

5.6.11.4.9. Cranes and work cages used to hoist personnel must be specifically approved by WSMC/SE.

5.6.11.5. Gantry and overhead bridge cranes used to lift:

5.6.11.5.1. Critical loads as defined in 5.6.11.4.3 above, will be initially tested to 125 percent of the rated load, and annually thereafter to 100 percent of rated load.

5.6.11.5.2. Noncritical loads will be initially tested to 125 percent of the rated load and every two years thereafter to 100 percent of rated load.

5.6.11.6. Crawler, locomotive, and truck mounted cranes, lifting critical loads as defined in 5.6.11.4.3 above, will be initially tested at 110 percent of the rated load and annually thereafter at 100 percent of the rated load. Such cranes, lifting noncritical loads, will be tested initially at 110 percent of the rated load and every two years thereafter at 100 percent of rated load.

5.6.11.7. Base-mounted drum hoists, lifting critical loads as defined in 5.6.11.4.3 above, will be initially tested at 110 percent of the rated load and annually thereafter at 100 percent of rated load. Such hoists, lifting noncritical loads, will be initially tested at 110 percent of the rated load and every two years thereafter at 100 percent of rated load.

5.6.11.8. All slings, riggers hardware, and special lifting fixtures will be proof-tested to 200 percent of the rated load prior to initial use at WSMC or after any modification or alteration. Synthetic slings must have a design margin so the proof load will not stress the fibers greater than their working strength.

5.6.11.8.1. Slings, riggers hardware, and specialized lifting fixtures used to lift critical loads as defined in 5.6.11.4.3 above, will be tested annually to 200 percent of rated load.

5.6.11.8.2. Slings, riggers hardware, and special lifting fixtures used to lift noncritical loads will be proof-tested according to 5.6.11.8 above and then periodically tested at the discretion of the user, not to exceed a three-year interval. This load test must not be used as a substitute for inspections and must not exceed 200 percent of the rated load.

5.6.11.8.3. The proof-load for single leg slings and endless slings must be two times the vertical-orientation rated capacity.

5.6.11.8.4. The proof-load for multiple leg bridle slings will be applied to the individual legs and must be two times the vertical-orientation rated capacity of a single leg sling of the same size, grade, and construction of rope.

5.6.11.8.5. All slings must be visually inspected each day prior to use. A periodic inspection must be performed by the using organization on a regular basis (annually as a minimum) with frequency of inspection based on:

5.6.11.8.5.1. Frequency of sling use.

5.6.11.8.5.2. Severity of service conditions.

5.6.11.8.5.3. Nature of lifts being made.

5.6.11.8.5.4. Experience gained on the service life of slings used in similar circumstances.

5.6.11.8.5.5. Any deterioration that could result in appreciable loss of original strength must be carefully noted and a determination made whether or not further use of the sling would constitute a hazard.

5.6.11.8.6. The identification and record-keeping requirements of ANSI B30.9 and OSHA 1910.184 must be applied. Identification tags, as a minimum, must indicate inspection dates, proof-test dates, and load rating. Identification tags and records for all slings must be maintained by the user.

5.6.11.8.7. Wire rope slings must be removed from service immediately if any of the conditions listed below exist. Sling assemblies must be repaired, refurbished, and retested before further use is permitted.

5.6.11.8.7.1. Six randomly distributed wires are broken in one rope lay, or three broken wires in one strand in one rope lay.

5.6.11.8.7.2. One-third of the original diameter of the outside individual wires are worn or scraped away.

5.6.11.8.7.3. The wire rope structure is distorted by kinking, crushing, birdcaging, or other damage.

5.6.11.8.7.4. Heat damage is evident.

5.6.11.8.7.5. End attachments are cracked, deformed, or worn.

5.6.11.8.7.6. The rope or end attachment is corroded.

5.6.11.9. If hooks have been opened more than 15 percent of the normal throat opening, measured at the narrowest point, or twisted more than 10 degrees from the plane of the unbent hook, they must be removed from service. All hooks shall be equipped with a safety latching device.

5.6.11.10. Hydracranes and chainfalls must be given an initial load test and an annual test thereafter to 110 percent of rated load for hydracranes and 125 percent for chainfalls.

5.6.11.11. Hydrasets must be initially load tested to 200 percent and annually thereafter at 125 percent. They will be tested to 125 percent when seals are replaced. Manufacturer's certification of tests is acceptable for new and reworked hydrasets.

5.6.11.12. Spacecraft, payload, and missile slings which have components that are normally disassembled shall be either marked, coded, or tethered to assure proper assembly of verified hardware. Components not marked, coded, or tethered will invalidate the proof-load certification of the whole assembly.

5.6.12. Elevators:

5.6.12.1. Elevators are inspected and tested as required by applicable Air Force, ANSI A17.1 and A17.2 requirements.

5.6.12.2. Elevators at missile facilities must be equipped with emergency lights or lights tied into a backup emergency electrical system, a telephone, and a PA speaker where a PA system is available and in use.

5.6.12.3. Passenger elevators must not be used for freight, ordnance, propellant or other hazardous commodity without specific approval of WSMC/SE.

5.6.12.4. Freight elevators used for the movement of ordnance that has been removed from original shipping containers, toxic propellants, or other hazardous commodity are controlled remotely. Personnel must not ride in the elevator during movement of the above commodities. Exceptions to the above must be approved by WSMC/SE on a case-by-case basis.

5.7. Mishap Reporting. WSMC/SE is responsible for reporting all ground, missile, and space mishaps occurring to resources under the control of the WSMC/CC. WSMC/SEM is responsible for participating in the investigation and making sure required reports are accomplished according to AFR 127-4, as supplemented, and AFR 127-2. Range users must make sure all mishaps are properly documented and expeditiously reported to WSMC/SEM.

5.8. Launch operations:

5.8.1. Minimum launch requirements:

5.8.1.1. The CSO is the Range Commander's representative for ground safety at the launch complex and in the blockhouse. At the time specified in the applicable documents (user launch countdown and precount), the CSO must be on station at the safety console in the blockhouse or launch control center.

5.8.1.2. The CSO is responsible for clearing all nonessential personnel from the pad danger area during caution periods and for proper housing of essential personnel in the missile flight hazard area during danger periods. The CSO controls all signaling services provided to indicate caution and danger periods. Caution and danger periods are declared by the CSO at the times specified by applicable safety plans, countdown manuals, hazardous operation procedures, or at any time such action becomes necessary in the interest of safety. At a mutually agreed upon point in the countdown, the CSO must report verbally to the MFCO that "The danger area is clear for launch."

5.8.1.3. The blockhouse door security guard does not permit anyone to leave the blockhouse unless specifically authorized by the CSO.

5.8.1.4. Searchlight and photographic supervisors must report to pad safety when clearing the complex and upon arrival at the fallback position.

5.8.1.5. In addition, the CSO must:

5.8.1.5.1. Make sure a launch support team is in place at the fallback position for each static firing or launch.

5.8.1.5.2. Monitor the installation and electrical hookup of ordnance for safety.

5.8.1.5.3. Approve the start of ordnance tasks.

5.8.1.5.4. Approve the start of propellant transfer and vehicle tanking.

5.8.1.5.5. Approve the start of vehicle pressurization.

5.8.2 Launch abort, misfire, or hangfire requirements:

5.8.2.1. Liquid and solid propellant vehicles - in the event of launch abort, hangfire, or misfire, the launch agency must disable the ignition firing circuit and depressurize the missile propellant tanks and pressure receivers to safe values. For missiles employing solid propellant starting devices, the CSO must restrict access to the pad until it can be verified that power did not reach the initiator (misfire), or it is assumed that power did reach the initiator (hangfire) and at least a 30-minute waiting period has elasped.

5.8.2.2. The CSO, in conjunction with the launch agency, will inspect the pad and allow access to it for work when it is safe to do so. When no further launch attempt is contemplated, verify that hazardous ordnance items are disconnected electronically and, if required, removed for return to the storage area.

5.8.3. Launch Support Team (LST) is responsible for immediate response to a missile and space vehicle abort on the launch pad or impacting on the VAFB land mass or the public domain. The duties and responsibilities of the LST are further defined in 1 STRADR 127-200.

5.8.3.1. The Range user is responsible for having the required missile launch crew at fallback area at least 60 minutes prior to T-0. (If more than one fallback position is used, the crew should report to the primary fallback area.)

5.8.4. Post Launch Requirements:

5.8.4.1. Immediately after a launch, the CST inspects the pad for personnel hazards, such as contamination, exposed wiring, damaged high pressure systems, or damaged propellant tanking systems.

5.8.4.2. The CSO coordinates with the LST chief, the Range Safety Officer, and the launch agency to determine when it is safe to permit personnel to leave the blockhouse or shelter.

5.8.4.3. The CSO directs the LST chief to adjust or lift roadblocks as warranted by existing conditions. Fire, medical, and security support is released when no longer needed and normal security measures are instituted.

5.9. Construction Contractors:

5.9.1. Construction contractors must comply with Corps of Engineers (COE) 5.9.25-1-1, when applicable, OSHA, Air Force and other recognized standards for operations that involve construction, refurbishing, installation, and maintenance activities. Contractors must protect the health and safety of workers and all subcontractors who come in contact with their operation or services. Contractors must establish:

5.9.1.1. Safe operating procedures.

5.9.1.2. Accident investigation and reporting procedures.

5.9.1.3. Medical treatment and first aid instructions.

5.9.1.4. Procedures for correcting hazards.

5.9.1.5. Security and smoking regulations.

5.9.1.6. Instructions for placement of barriers, warning signs, and lights.

5.9.1.7. Procedures for the use of protective clothing and equipment.

5.9.1.8. Schedule of safety inspections of work site.

5.9.2. Each construction contractor shall appoint a formally trained individual to act as his safety representative. The appointed individual functions as the single point of contact on all problems involving job site safety. The prime contractor's safety representative establishes coordination procedures with WSMC/SE and subcontractor safety personnel. During performance of work, each contractor must comply with all provisions and procedures prescribed for the control and safety of his people and visitors to the job site. The contractor must maintain an accurate record of all accidents and incidents resulting in property damage, injury, or death relating to the work performed. A procedure to promptly notify the administrative contracting officer and WSMC/SE when an accident or incident occurs must be in effect.

5.9.3. The Administrative Contracting Officer (ACO) must notify the prime contractor of reported safety violations and advise them to take corrective action. The affected contractor must take prompt corrective action on all violations noted. Failure to correct safety deficiencies is basis for stopping all or part of the work until satisfactory corrective action is completed. WSMC/SE shall be advised of corrective action taken on violations found during WSMC/SE inspections. The ACO will notify WSMC/SEM of preconstruction briefings.

5.9.4. The prime contractor is responsible for making sure job sites are inspected and monitored for safety deficiencies and must ensure that prompt action is taken to correct deficiencies.

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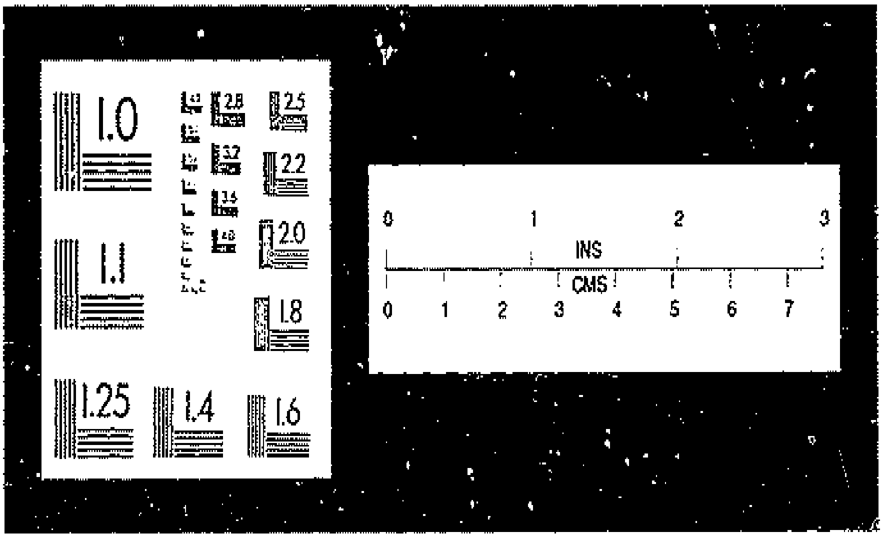

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6.5.2.3. A failure occurs in the mandatory flight safety tracking, telemetry, or data processing systems.

6.5.2.4. Predicted mission hazards are excessive.

6.5.2.5. A positive means of preventing launch during a flight safety hold is required.

6.6. Misfire and Hangfire. The missile countdown procedure must include misfire and hangfire procedures. In the event of a misfire or hangfire, the flight termination system must remain in a launch mode (armed and on missile power) until all of the following have been accomplished:

6.6.1. The missile launch control system is deactivated (for example, launch commands have been inhibited and engine ignitor S&A devices have been safed). The specific procedure acceptable to WSMC/SE depends on the type and nature of the missile system and launch facility.

6.6.2. For solid propellant missiles, a minimum waiting period of 30 minutes is required whenever it cannot be positively identified that ignition current did not reach the igniter bridgewires.

6.6.3. Approval has been received from the MFCO to deactivate the flight termination control system.

6.7. Missile Lift-off Signal. The missile launch system must provide a positive lift-off indication to the Range for the purpose of initiating Range instrumentation and data processing sequences.

6.8. Crew time restrictions and fatigue precautions, paragraph 5.6.1.3.

6.9. Range Safety Instrumentation Requirements. Specific instrumentation support requirements for each missile and space launch program will be documented by the Missile Flight Control Operations Requirements generated by WSMC/SEO.

6.10. Flight Termination Actions. Flight termination action by the MFCO will consist of thrust termination and destruct. In some cases, destruct action may not be required subsequent to thrust termination. If MFCO reaction times prove inadequate to provide the level of safety required, flight termination may be required to be initiated automatically by computer. Any plans for computer generated flight termination will be coordinated with the range user.

6.11. Flight Termination Criteria. The following conditions will normally require flight termination by the MFCO:

6.11.1. Obviously erratic flight - vehicle performance is such that continuation of erratic flight can bring about loss of flight termination control. This action may be taken even though the vehicle has not violated the flight termination lines.

6.11.2. Flight abort line violation - data show that the vehicle violates the flight abort lines derived and defined by the Flight Analysis Division (WSMC/SEY).

6.11.3. Performance unknown - vehicle performance is unknown and the capability to violate an impact limit line exists.

6.12. Mission rules - mission rules generated by the WSMC/SEO will specify mission-peculiar details or modifications of the general operational requirements covered in this chapter.

OFFICIAL

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SUMMARY OF CHANGES
This regulation has been completely revised, reorganized, and updated; the basic premises of Range Safety and the philosophy of operation have not changed and the sole purpose in reissuing this regulation is to clarify and update Range procedures and operational requirements.

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EXPLANATION OF TERMS AND ABBREVIATIONS

ACCEPTABLE HAZARD. The acceptability of any hazard imposed by a missile or orbital vehicle launched from or into the Range is solely the responsibility of the Commander. The level of acceptability varies with operational requirements and is determined by the Commander on a case-by-case basis after a thorough review.

ACCEPTED RISK. A residential hazard which after thorough review and evaluation has been accepted by program management.

ADEQUATE SOURCE. A data source that enables the MFCO to determine when a missile or space vehicle violates established in-flight safety criteria.

AEC. Atomic energy commission.

AERODYNAMIC VEHICLE. A vehicle that has lifting and control surfaces to provide stability control and maneuverability. The flight profile during and after thrust depends primarily upon aerodynamic forces.

AFCO. All fuel cutoff.

AFOSH. Air Force Occupational Safety and Health.

AFSC. Air Force Systems Command.

AFWL. Air Force Weapons Lab.

AGC. Automatic gain control.

AGE. Aerospace ground equipment.

ALGORITHM. A finite set of well-defined rules for the solution of a problem in a finite number of steps.

AMBER TIME. The period of time between missile lift-off and the first possibility of a missile's instantaneous impact point moving to a protected area. Normally, a missile is destroyed if it is not being tracked at the expiration of the amber time period.

ANSI. American National Standards Institute.

AOS. Acquisition of signal.

APPLICATION SOFTWARE. Software specifically produced for the functional use of a computer system; for example, software for navigation, payload, general ledger. Contrast with system software.

ARAR. Accident risk assessment report.

ARMING PLUG. A removable device that provides electrical continuity when inserted in a firing circuit.

ARMING STATION. A protected location within the launch complex containing the missile igniter firing circuit where the arming plug may be installed (firing or arming).

ARTC. Air route traffic control.

ASME. American Standard of Mechanical Engineers.

AUTHORIZED PERSONNEL. Those personnel who have security and safety badges, but are prohibited entry into safety control areas because of not meeting the requirements of essential or mission essential personnel.

AUTOMATION. The use of software to perform tasks with minimum operator action or interface.

AUXILIARY ENGINE. A power source used to operate parts of the integral equipment (such as a gasoline-powered electric generator).

AVE. Airborne vehicle equipment.

BALANCED CIRCUIT. A two-conductor circuit where the voltage relative to ground on the conductors is equal in magnitude and opposite in polarity at every point along the line.

BALLISTIC FLIGHT. A missile flight where the flight path is determined by the launch angles, missile velocity, forces of gravity, and aerodynamic drag.

BCD. Binary coded decimal (6-bit character code).

BECO. Booster engine cutoff.

BER. Bit error rate.

BET. Best estimate of trajectory.

BLOCK DIAGRAM. A diagram of a system, a computer, or a device in which the principal parts are represented by suitably annotated geometrical figures to show both the basic functions of the parts and their functional relationships. Contrast with flowchart.

BOA. Broad ocean area.

BOOSTER IMPACT AREA. An area under the normal flight path into which a booster will return to the surface of the earth.

CASPER. Contact areas summary position estimate report.

CATEGORY A ORDNANCE DEVICES. Category A electro-explosive devices are those that, by the expenditure of their own energy or because they initiate a chain of events, may cause injury or death to people or damage to property.

CATEGORY B ORDNANCE DEVICES. Category B electro-explosive devices are those that do not, in themselves, or by initiating a chain of events, cause injury to people or damage to property.

CCT. Command control transmitter.

CCTV. Closed circuit television.

CD. Common digitizer.

CDF. Confined detonating fuse.

CDR. Critical design review.

CENTRAL PROCESSING UNIT (CPU). The central electronic device which actually executes the software. (Usually surrounded by peripheral devices such as memory, buffers, decoders, etc., which allow interaction with the rest of the system involved.)

CEP. Circle of equal probability, also called circular error probable, circle of probable error.

CFR. Code of Federal Regulations.

CG. Center of gravity.

CHECK CHANNEL. A single tone modulation utilized as a monitor for checkout and inflight performance of the receiver-decoder.

CHOCK. Any piece of material used to prevent motion of a wheel or roller beyond the point of application until the chock is removed.

CL. Checklist.

CLARITY. The functions and operation of the programs are easily understood from the user manual, and the program design and structure are readily apparent from the listing of program statements. This means that the documentation must be well written, but also that the program is carefully designed, with meaningful choices of variable names, use of known algorithms, frequent and effective comments in the program to describe its operation, and a modular structure that isolates separate functions for examination.

CMAA. Crane Manufacturers Association of America.

CSO - COMPLEX SAFETY OFFICER. A representative of the WSMC or 1 STRAD Commander, specifically qualified and designated to monitor and supervise the safety aspects of missile launch preparations and operations.

CST - COMPLEX SAFETY TECHNICIAN. The on-site representative of the CSO responsible for verifying, advising, and assisting the CSO during hazardous or dangerous operations.

COE. Corps of Engineers.

COMPUTER PROGRAM. A sequence of instructions suitable for processing by a computer. Processing may include the use of an assembler, a compiler, an interpreter, or a translator to prepare the program for execution as well as to execute it.

COMPUTER SYSTEM. A functional unit, consisting of one or more computers and associated software, that uses common storage for all or part of a program and also for all or part of the data necessary for the execution of the program; executes user-written or user-designated programs; performs user-designated data manipulation, including arithmetic operations and logic operations; and that can execute programs that modify themselves during their execution. A computer system may be a standalone unit or may consist of several interconnected units. Synonymous with ADP System or computing system.

CONCURRENT PROCESSES. Process that may execute in parallel on multiple processors or asynchronously on a single processor. Concurrent processes may interact with each other, and one process may suspend execution pending receipt of information from another process or the occurrence of an external event. Contrast with sequential processes.

CONFIGURATION CONTROL. The systematic evaluation, coordination, approval or disapproval, and implementation of all approved changes in the configuration of a configuration item after formal establishment of its configuration identification.

CONFIGURATION MANAGEMENT. A discipline applying technical and administrative direction and surveillance to:

a. Identify and document the functional and physical characteristics of a configuration item.

b. Control changes to those characteristics.

c. Record and report change processing and implementation status.

CONTINUOUS WAVE (CW) THRESHOLD SENSITIVITY. That RF level at F_0 that produces an increase of 1 dB over the quiescent signal strength voltage level.

CORRECTNESS. Programs perform exactly and correctly all the functions expected from the specifications, if available, or else from the documentation. This means that incorrect documentation is as serious as an incorrect program. Correctness is an ideal quality that is rarely determinable, so a more practical quality is Reliability.

CPR. Cardio pulmonary resuscitation.

CRITICAL SOFTWARE MODULE. Those software modules containing operations that, if not performed, performed out-of-sequence or performed incorrectly could result in improper control functions (or lack of control functions required for proper system operation) which could directly or indirectly cause or allow a hazardous condition to exist.

CURRENT SENSITIVITY. The least amount of current required to initiate a particular EED at a specified probability and confidence level when conditions of EED temperature and power application are specified.

CTSC. Center Technical Services Contractor.

CW. Continuous wave.

DAC. Duty air controller.

DANGER AREA. A controlled surface area centered on the missile or applicable hazard. The size and shape of the area varies, depending on the nature and explosive potential of the propellants or other materials associated with the particular missile system involved and whether the operation is above or below ground level.

DANGER PERIOD. The period of time when the danger area is activated.

DANGEROUS OPERATION. A specific operation requiring activation of a danger area(s) as specified in the appropriate missile system documentation.

DATA FLOW DIAGRAM. A graphic representation of a system, showing data sources, data sinks, storage, and processes performed on data as nodes, and logical flow of data as links between the nodes. Synonymous with data flow graph, data flow chart.

dB. Decibels.

DC. Direct Current.

DECODER ACCEPT LIMITS. The permissible tolerances to variations in interrogation code group pulse spacing to which the transponder will reply positively.

DECODER REJECT LIMITS. The variations in interrogation code group pulse spacing to which the transponder does not reply positively.

DEVIATION. To depart from the exact statement of a requirement, but at the same time maintain the intent of the requirement.

DID. Data Information Description.

DISARMING. The normal method of returning ordnance systems or components to a safe status.

DOD. Department of Defense.

DOT. Department of Transportation.

DPL - DOUBLE PROPELLANT LOADING. An operation involving the transfer of both fuel and oxidizer, or of loading or unloading one propellant when the other is aboard the vehicle.

EBW. Exploding bridgewire.

EBW FIRING CIRCUIT. The wiring and components that provide the high voltage and trigger circuits for the EBW initiator.

EBW INITIATOR. That part of the EBW system that initiates the explosive train by shock wave action due to the magneto hydrodynamic effect. This effect is created by discharging a very high current, from a discharging capacitor, through the bridgewire.

EBW SYSTEM. The combination of EBW initiator and firing circuit.

EED - ELECTRO-EXPLOSIVE DEVICE. A single electrically actuated explosive initiator of either the HBW type and its variations or the EBW type.

EED FIRING. The ignition or initiation of the prime explosive surrounding the bridgewire.

EED FIRING CIRCUIT. The wiring and components that provide a closed path from the power source to the EED bridgewire.

EED LEADS. The conductors that are part of the EED (pins or pigtail) and provide an electrical path to the bridgewire.

EFFICIENCY/ECONOMY. Programs have high performance algorithms and conservatively use computer resources, such as main storage, so that the cost of program operation is low.

EMBEDDED COMPUTER SYSTEM. A computer system that is integral to a larger system whose primary purpose is not computational; for example, a computer system in a weapon, aircraft, command and control, or rapid transit system.

EMBEDDED SOFTWARE. Software for an embedded computer system.

EMI. Electro-magnetic interference.

ENGINE CUT-OFF. The termination of the propulsion sequence by a command signal.

EOD ELEMENT. A section responsible for functions incident to the detection, identification, rendering safe, recovering, field evaluation, and disposal of ordnance or explosive materials that have been dropped, damaged, fired, or placed in a configuration that could endanger property or people.

EOD - EXPLOSIVE ORDNANCE DISPOSAL. As applied to WSMC, the action taken by qualified military EOD personnel to minimize the hazards involving explosive ordnance.

EOD PERSONNEL. Military personnel trained by DOD in safing and disposing of ordnance and explosive material.

ESD. Engine shutdown.

ESSENTIAL ACTIVITIES. Only those required activities directly related to hazardous or dangerous operations being performed. Normally these activities require activation of safety control areas.

ESSENTIAL EQUIPMENT. Installed or portable equipment necessary to conduct a specific operation.

ESSENTIAL PERSONNEL. The minimum number of persons necessary to successfully and safely complete a hazardous or dangerous operation. This term also includes:

a. People required to perform emergency actions according to authorized directives.

b. Trainees required for instructional purposes.

c. People required to perform safety or technical surveillance of the operation.

d. People specifically authorized by the WSMC/CC to perform scheduled activities. The Range user and launch commander determines, with WSMC/SE approval, the number of persons essential to the operations.

FAA. Federal Aviation Agency.

FACTORY-TO-PAD. Factory-to-pad concept missile systems are planned so that flight hardware is launch ready when the missile is shipped from the missile contractor's plant facility. In this concept, all possible tests and installations are accomplished by contractor test teams at the contractor's plant facility before shipment to the launch base.

FAIL-SAFE. The ability to sustain failure and retain the capability to successfully terminate the mission. For GSE, the ability to sustain a failure without causing loss of vehicle systems or loss of personnel capability.

FAILURE. The termination of the ability of a functional unit to perform its required function. The inability of a system or system component to perform a required function within specified limits. A failure may be produced when a fault is encountered. A departure of program operation from program requirements.

FALLBACK AREA. A specified area located outside the missile flight hazard area used to position certain support personnel and equipment during missile launch operations as determined by the launch support team chief.

FAULT. A manifestation of an error in software. A fault, if encountered, may cause a failure. Synonymous with bug.

FAULT TOLERANCE. The built-in capability of a system to provide continued correct execution in the presence of a limited number of hardware or software faults.

FCA. Frequency control and analysis.

FIRMWARE. Computer programs and data loaded in a class of memory that cannot be dynamically modified by the computer during processing. For the purposes of system safety, firmware is to be treated as any other piece of software.

FLOWCHART. A graphical representation of the definition, analysis, or solution of a problem in which symbols are used to represent operations, data, flow, and equipment. Contrast with block diagram.

FMEA. Failure mode and effect analysis.

Fo. The Range user assigned operating frequency.

FPA. Flight plan approval.

FTCS - FLIGHT TERMINATION CONTROL SYSTEM. Equipment installed in the missile, plus associated ground equipment for tracking and terminating missile flight should it become necessary.

FTSA. Flight termination system analysis.

FTSR. Flight termination system report.

FUNCTION. A specific purpose of an entity or its characteristic action.

g-limits. Acceleration limits.

GEMS. General energy management system.

GENERALITY. Programs perform their functions over a wide range of input values and usage modes. Programs are not limited to special cases or range of values when the functions are commonly or reasonably extenuable to a more general case.

GERTS. General Electric Radio Tracking System.

GSE. Ground support equipment.

GSP. Ground safety plan.

HANGFIRE. Ignition has not occurred and it is not known positively that the firing current has not reached the igniter initiators.

HARDWARE. Physical equipment used in data processing, as opposed to computer programs, procedures, rules, and associated documentation. Contrast with software.

HAZARD. The presence of a potential risk situation either caused by an unsafe act or condition or resident in the system by virtue of the inherent energy sources utilized in the system.

HAZARD ANALYSIS. The analysis of systems (hardware, software, firmware, and user-system interface) to determine potential hazards which could result in loss of personnel, injury to personnel, loss or degradation of the system, loss or degradation of mission capability or loss of life or injury to the public. The analysis must not only identify hazards but also must recommend actions to eliminate or control the hazards.

HAZARD AREA. A controlled surface area centered on the hazardous operation being performed. The area size and shape varies and depends upon the nature of the operation, missile system, and materials involved.

HAZARD PERIOD. The period of time the hazard area is activated.

HAZARDOUS CONDITION. A situation where significant risk exists because of the nature of the operation being performed and materials being handled. For example, hazardous conditions exist:

a. During propellant transfer to or from a missile; whenever work is in progress on a missile containing liquid propellants; and whenever a solid propellant missile is being installed or removed.

b. During installation, electrical connection, testing, and handling of ordnance items, and while ordnance items are electrically connected in the missile.

c. Whenever missile pressurization systems fail to meet safety design requirements and high pressure tests are being conducted.

d. Whenever any toxic or flammable materials are used for any purpose.

e. Whenever radioactive items deemed a hazard are introduced into any area.

f. Whenever hazardous noise, as defined in applicable Air Force regulations or manuals, is generated.

g. Any time that electrical storms are within 10 miles of the complex, or when meteorological forecasts predict that any adverse condition exists prior to the completion of any operation that cannot be terminated if ordnance items or propellants are aboard the missile.

HAZARDOUS OPERATIONS. Certain functions and procedures accomplished during missile operations that have been designated as hazardous operations (chapter 3). These operations require supervision by people specifically assigned the responsibility of ensuring that all safety considerations are met.

HBW. Heated bridgewire.

HOP. Hazardous operations procedure.

HUMAN ENGINEERING. Application of scientific knowledge to the design of items to achieve effective user-system integration and utilization.

HUMAN FACTORS. Includes principles and applications in areas of human engineering, personnel selection, training, life support, job performance aids and human performance evaluation.

HUMAN PERFORMANCE. Measure of man-functions and actions in specified environment.

HZ. Hertz (frequency).

IEEE. Institute of Electrical and Electronic Engineers.

IG. Inertial guidance.

IIP. Instantaneous impact prediction.

ILL - IMPACT LIMIT LINE. A line defining a limit beyond which a missile and spacecraft, or specified portions thereof, must not be allowed to impact.

IMPACT AREA. The area surrounding an approved impact point. The extent and configuration of the area is based on the vehicle or stage dispersion characteristics.

IMU. Interial Measurement Unit.

INHERENT. Achievable under ideal conditions generally derived by analysis and potentially present in the design.

INTEGRATION. The process of combining software elements, hardware elements, or both into an overall system.

INTERFACE.

a. A shared boundary. An interface might be a hardware component to link two devices or it might be a portion of storage or registers accessed by two or more computer programs.

b. To interact or communicate with another system component.

INTERFACE TESTING. Testing conducted to ensure that program or system components pass information or control correctly to one another.

INTERROGATION CODE PULSE SPACING. The time interval measured between 50 percent amplitude points on the leading edges of the interrogation code group voltage pulses.

IONIZING RADIATION. Gamma and X-rays, alpha and beta particles and neutrons; but not sound or radio waves, or visible, infrared, or ultra-violet light.

IRIG. Inter-Range instrumentation group.

IRV. Inter-Range vector.

kHz. Kilohertz.

LAAFS. Los Angeles Air Force Station.

LAL. Launch Approved Letter.

LAUNCH COMPLEX. Area, usually fenced, containing the missile launching facilities, including the launch pad and servicing structures, blockhouse or control building, propellant transfer equipment, support buildings, and all other facilities in the immediate vicinity required to support a missile launch.

LCC - LAUNCH CONTROL CENTER. That room or area where launch operations are conducted.

LCO - LAUNCH CONTROL OFFICER. Individual who supervises and coordinates activities in the launch complex during prelaunch and postlaunch.

LAUNCH SUPPORT PLAN. A base safety support plan specifying LST elements, support schedule timing milestones, reporting instructions, and other special support instructions for a specific launch operation.

LCSOP. Launch Complex Safety Operating Procedure (WSMCR 127-2, vol II).

LCSP. Launch complex safety plan.

LEL. Lower explosive limit.

LF. Launch facilty.

LIMITED RADIATION NO SWITCHING. That state imposed by the pad site commander where switches that might create a radio frequency hazard in the vicinity of the emplacement are not allowed to be operated. This also applies to automobile ignition, electronic signal generators, and automobile radio transmitters in the vicinity. Limited radiation no switching periods apply when electrically fired explosives are being electrically connected or disconnected.

LONOTE. Local notice to mariners.

LO_2 or LOX. Liquid oxygen.

LOCC. Launch operations control center (Bldg 7000).

LOS. Loss of signal.

LST - Launch Support Team. A team composed of a variety of technical specialists, prepositioned for rapid response to any emergency or disaster occurring during missile launch operations.

MAC. Maximum allowable concentration.

MAINTAINABILITY. Programs are well documented by manuals and internal comments and so well structured that another programmer could easily repair defects or make minor improvements. Clarity is essential for maintainability. Also implied are a wide variety of good design attributes, such as program functions that help to diagnose potential problems (such as periodic reports of status or control totals) or general techniques that can be readily adapted for change (such as the isolation of constants, report titles and other static data as named variables).

MAN-FUNCTION. Allocated to the human component of a system.

MDF. Mild detonating fuse.

MECO. Main engine cutoff.

MFCA. Missile flight control area.

MFCO - MISSILE FLIGHT CONTROL OFFICER. An Air Force Officer who monitors the performance of missiles and space vehicles in flight and initiates flight termination action when required. He or she is the direct representative of the Range Commander during the prelaunch countdown and during missile powered flight (MFCO is also used by some Range users to designate manual fuel cutoff).

MFCORD. Missile flight control operations requirements document.

MFHA. Missile flight hazard area.

MHI. Material Handling Institute.

MHz. Megahertz

MINIMUM RADIATION CONTROLLED RADIATION. Includes criteria under limited radiation or switching, and is that state where all high powered radar and other high powered radio frequency transmitters are required to cease radiating (or to beam away).

MISFIRE. When it is positively known that ignition voltage has not reached igniter initiators during a launch attempt.

MISSILE. No distinction is made between sub-orbital, orbital, escape vehicles, and missiles in this publication. All are referenced as missiles. This term refers to any category of launch vehicle, spacecraft, or combination thereof.

MISSILE FLIGHT CAUTION AREA. That ground outside of the missile flight hazard area where injury or property damage could occur because of a missile flight failure. This area is restricted and only essential personnel are allowed to remain within the missile flight caution area during launch operations.

MISSILE FLIGHT HAZARD AREA. That area where significant danger to personnel and equipment would exist in the event of a malfunction during the early phases of missile flight. It is the ground and air space extending to an unlimited altitude, and including the entire area where the risk of serious injury, death, or substantial property damage is so severe it necessitates exclusion of all personnel and equipment not needed to conduct the launch operation. Personnel required to be in this area during a launch operation must be located in blast-hardened and approved shelters.

MISSILE GROUND SAFETY. Those safety considerations and procedures associated with, and peculiar to, handling of missiles and missile components preparatory to prelaunch, launch, and postlaunch in the event of inadvertent land impact.

MISSILE HAZARD SPACE. A volume originating at the launch point within which a vehicle, its fragments, or its nuclear or toxic contamination is contained either as a result of its maximum aerodynamic ballistic capability or controlled flight termination. The missile hazard space varies according to the characteristics of the particular vehicle involved and the Range safety limitation imposed for flight termination. It must be specifically prescribed for each missile launch operation.

MISSILE OPERATIONS. All activities involving missiles or space vehicles and their support systems and facilities.

MISSILE RULES. Rules agreed upon between the Range user and WSMC specifying those requirements and procedures not covered in this regulation.

MISSION ESSENTIAL PERSONNEL. Those personnel who do not meet the requirements of essential personnel, but may be permitted within safety control areas to prevent a mission impact. All requests to enter requires WSMC/SE approval on a case-by-case basis.

MMH. Monomethylhydrazine.

MODIFIABILITY. Program functions that might require major changes are well documented and isolated in distinct modules. Maintainability is essential to modifiability. Modifiability means that a concerted effort was made to anticipate major changes and to plan the software design so that they could be made easily.

MODULE.

a. A program unit that is discrete and identifiable with respect to compiling, combining with other units, and loading; for example, the input to, or output from, an assembler, compiler, linkage editor, or executive routine.

b. A logically separable part of a program.

MOSR - MISSILE OPERATIONS SUPPORT REQUIREMENTS. A 1 STRAD Form 36 listing all support requirements (safety and otherwise) needed in support of a particular operation. The use of this form is mandatory for all hazardous, dangerous operations conducted at Vandenberg AFB.

MSGSA. Missile system ground safety approval.

mw. Milliwatt.

N_2O_4. Nitrogen tetroxide.

NASC. National Aeronautics and Space Council.

NDI. Nondestructive inspections.

NDT. Nondestructive testing.

NEC. National Electrical Code.

NFPA. National Fire Protection Association.

NFS. Near field signature.

NFS. National fire standard.

NIOSH. National Institute of Occupational Safety and Health.

NM. Nautical miles.

NO-FIRE. A failure of an EED to fire when electrical energy is applied, or the rendering of an EED to a permanent inoperative state without any ignition process occurring (dudding).

NO-FIRE CURRENT. The current sensitivity where no more than one EED per thousand will fire with a confidence of 95 percent.

NO-FIRE POWER. The power sensitivity where no more than one EED per thousand will fire with a confidence of 95 percent.

NONCOOPERATIVE LAUNCH. A separate launch not coordinated with a manual launch already in orbit.

NONESSENTIAL PERSONNEL. Personnel who do not meet the criteria for essential personnel and whose absence would not hinder the successful completion of an operation that required activation of a safety control area.

NOMINAL SENSITIVITY. The receiver decoder design guaranteed RF signal level which, when applied within the operating bandwidth, produces a desired output.

NORMAL VEHICLE. A properly performing vehicle whose instantaneous impact point (IIP) does not deviate more than three standard deviations from the intended IIP locus.

NOTAM. Notice to Airmen.

NRC. Nuclear Regulatory Commission.

NSCCA. Nuclear Safety Cross Check Analysis.

O&C. Operation and control console.

O&M. Operation and maintenance.

OD. Operations directive.

OP. Operating procedure.

OPEN LOOP FLIGHT TERMINATION CONTROL SYSTEM VERIFICATION CHECKS. Operation checks of the flight termination system using electromagnetic radiation between transmitting and receiving antennas.

OPERATING BANDWIDTH. The frequency displacement from F sub o or the modulated carrier over which a command function can be initiated and maintained at the nominal sensitivity level.

OR. Operations requirements.

ORBITAL INJECTION. Orbital injection occurs when a vehicle achieves a combination of velocity and position so that without additional thrust at least one orbit of the earth is made.

OSHA. Occupational Safety and Health Act.

OVERINTERROGATION PROTECTION. The protection afforded the transponder transmitter by circuitry designed to limit response rates to values that do not exceed the transmitter's maximum duty cycle limitation.

PA. Public address.

PAM. Pulse amplitude modulation.

PCM. Pulse code modulation.

PDR. Preliminary design review.

PEAK POWER OUTPUT. The required minimum peak power applied at the transponder antenna terminal under all operating conditions, normally computed from average power measurements.

PEL. Permissible exposure limit.

PETN. Pentaerythritol tetranitrate.

PFE. Polytetrafluoroethylene.

PI. Program instruction.

PIGA. Pendulous integrated gyroscopic accelerometer.

PMEL. Precision measurement equipment laboratory.

PMTC. Pacific Missile Test Center.

POSITIVE PROTECTION. Provide a definite means of protection, such as shelters, destruct line, or protective clothing as opposed to quasi-protection obtained from probability studies.

POTENTIAL TOXIC AREA. An area outside of which a specified maximum concentration of toxic gases predicted to contain excess toxic vapors or fumes is not to occur.

POWER SENSITIVITY. The least amount of electrical power required to initiate a particular EED at a specified probability and confidence when conditions of EED temperature and power application are specified.

PP. Present position.

PRD. Program requirements document.

PRELAUNCH SAFETY PROCEDURES. Procedures involving all safety functions at the Range from the receipt of missiles, space vehicles, and components until launch.

PRESSURE, DESIGN BURST. The maximum design strength of a pressure vessel (the pressure where the vessel is expected to fail).

PRESSURE, MAXIMUM ALLOWABLE WORKING. The maximum operating pressure permissible for a vessel at the operating temperature specified for that pressure.

PRESSURE, OPERATING. Operating pressure is the system pressure that is at or below the maximum allowable working pressure.

PRESSURE, PROOF. The test pressure applied to a pressure vessel and system without permanent set or deformation adversely affecting performance or safety.

PRESSURE SYSTEM. A pressure system is defined as any system above 0 psig and is classified as follows:

Low Pressure	0 to 500 psi
Med Pressure	501 to 3000 psi
High Pressure	3001 to 10,000 psi
Ultra-High Pressure	Above 10,000 psi

NOTE: It must be remembered, however, that the degree of hazard in pressure systems is proportional to the amount of energy stored, not the amount of pressure present. Therefore, low pressure, high volume systems can be as hazardous to personnel as high pressure systems.

PRF - PULSE REPETITION FREQUENCY. The number of pulses, or pulse groups in the case of multiple pulse codes, that occur per second.

PROCEDURE. A portion of a computer program which is named and which performs a specific task.

PROCESS. In a computer system, a unique, finite course of events defined by its purpose or by its effect, achieved under given conditions.

PROGRAM. See Computer Program.

PROPULSIVE STATE. Any configuration of a stage (or stages) of a missile that would move an appreciable distance in case of ignition.

PSM. Program support manager.

PSP. Program support plan.

PSS. Premature separation system.

PTA. Potential toxic area.

PULSE FALL TIME. The time required for the trailing edge of a voltage pulse to decrease from 90 percent to 10 percent of the amplitude of the pulse.

PULSE RISE TIME. The time required for the leading edge of a voltage pulse to increase from 10 percent to 90 percent of the amplitude of the pulse.

PULSE WIDTH. The time interval when a pulse exceeds a specified reference level. Pulse duration measurements are usually referenced to the pulse half power points.

QD. Quantity distance.

QE. Quadrant elevation.

RAM. Random Access Memory. Provides immediate access to any storage location point in memory. May be written to as well as read during program execution.

RANDOM TRIGGERINGS. The transmissions by the transponder that are not synchronized with valid interrogations.

RATED OPERATING CONDITIONS. The speeds, pressures, temperatures, stresses, and capacities of a component, or system of components, that have been designed, tested, and qualified according to applicable mandatory specifications.

RMCR - RANGE MISSILE CONTROL REPRESENTATIVE. A representative of the Range Commander specifically qualified and designated to make sure that the flight termination control system is designed properly and is operational.

RCC. Range Commanders' Council.

RCCRSG. 'Range Commanders' Council Range Safety Group.

RCO. Range Control Officer.

RDX. Research department explosive (Cyclotrimethylene trinitramine).

REAL TIME. Pertaining to the processing of data by a computer in connection with another process outside the computer according to time requirements imposed by the outside process. This term is also used to describe systems operating in conversational mode, and processes that can be influenced by human intervention while they are in progress.

RECEIVER BANDWIDTH. The width of the frequency passband at the specified attenuation, referenced to trigger sensitivity threshold.

RECEIVER CENTER FREQUENCY. The numerical midpoint between the upper and lower frequencies of the passband, measured at points corresponding to a 3 dB signal increase from trigger sensitivity threshold.

RECEIVER DYNAMIC RANGE. The range of signal levels where the transponder reply is with optimum accuracy to valid stimuli. This range is described as being from 0 dBm to a point 5 dBm above trigger sensitivity.

RECEIVER TRIGGER SENSITIVITY. The minimum signal level, measured at the antenna terminal of the transponder, that causes the transponder to reply properly to at least 99 percent of the valid interrogations per second with less than 5 pps response to random noise.

RENDER SAFE. The operation of rendering safe the ordnance systems or components to a safe status in the event of vehicle impact or aborted launch, or under circumstances when normal disarming cannot be accomplished.

REPLY DELAY. The time interval between 50 percent amplitude points of a pulse voltage measured from the leading edge of the last pulse of the interrogating code group to the leading edge of the transmitted reply pulse.

REPLY DELAY JITTER. The pulse to pulse variation in delay at constant input signal level.

REPLY DELAY VARIATION. The total (absolute) variation in delay to signal levels within the dynamic range of the transponder.

REPLY LOCK-OUT. The protection afforded the transponder by circuitry designed to inhibit transmitter response during recovery time and thus assure optimum reply performance.

REQUIREMENT. A condition or capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification, or other formally imposed document. The set of all requirements forms the basis for subsequent development of the system or system component.

RESILIENCE. Programs continue to perform in a reasonable way despite violations of the assumed input and usage conventions. Input of unacceptable data or an inconsistent command should never cause a result that is astonishing and detrimental to the user.

RF. Radio frequency.

RF FIELD POWER DENSITY. The power flux density or electro-magnetic waves passing through a surface normal to the direction of propagation.

RF FIELD STRENGTH. The magnitude of the electric or magnetic field vector (E or H) at a given location resulting from the passage of radio waves.

RF PROTECTION. A state where all electronic signal generators, radio transmitters, and electrically powered equipment that operates within a specified radio frequency band must be turned off if they will interfere with the operation in progress.

RF RADIATION. Electromagnetic wave propagation in the frequncy range of 0.15 MHz to 40,000 MHz, incapable of ionizing but capable of transferring energy into electronic and physiological systems.

RF SUSCEPTIBILITY. The magnitude of the smallest RF field, expressed as an RF field intensity (watts meter) of RF field strength (volts meter), capable of producing a no-fire current or no-fire power in an EED.

RFI. Radio frequency interference.

RMCR. Range Missile Control Representative.

RMS. Root mean square.

ROM. Read Only Memory. (See Firmware.)

ROS. Range Operations Supervisor.

ROSE. Rising observation sounding equipment.

ROUTINE.

a. A computer program segment that performs a specific task.

b. A program, or a sequence of instructions called by a program, that may have some general or frequent use.

RPP. Radiation protection plan.

RSC. Range statement of capability.

RSO. Range Safety Officer.

RSS - RELATIVE SIGNAL STRENGTH. DC voltage output from the flight termination control system command receiver utilized as a monitor of the RF input to the command receiver decoder.

RSV. Ready storage vessel.

RTDHS. Real time data handling system.

S & A - Safe and Arm Device. An electro-mechanical device used to ensure initiation of an ordnance train on proper command and to prohibit initiation of the train by a random or inadvertent firing signal or stray energy.

SABER. Supersonic aircraft boom effects routine.

SAC. Strategic Air Command.

SAE. Society of Automotive Engineers.

SAFETY. Conservation of human life and its effectiveness and the prevention of damage to items consistent with mission requirements.

SAFETY CONCERN. An accident risk factor or hazard that is considered credible and of such significance that it is identified to program management. All safety concerns are documented in the ARAR and are tracked to resolution.

SAFETY CONTROL AREA. An area where personnel and equipment exposure is controlled in order to limit the risk from a hazardous or dangerous operation.

SAFING. The action taken by the MFCO, while the missile is in flight that precludes any further capability of the missile's receiving ARM or DESTRUCT. Also used to describe the act of reducing the state of an "Armed" ordnance device to "safe" by electrical or mechanical means.

SAR. Special access required search and rescue.

SAS. Safety analysis summary.

SDO. Senior duty officer.

SDR. System Design Review.

SE. WSMC Range Safety Office.

sec. Seconds.

SECO. Sustainer engine cutoff.

SEED. Safe eye exposure distance.

SEM. WSMC Pad and Industrial Division.

SEO. WSMC Missile Flight Control Division.

SEQUENTIAL PROCESSES. Processes that execute in such a manner that one must finish before the next begins. Contrast with concurrent processes.

SES. WSMC System Safety Division.

SEY. WSMC Flight Analysis Division.

SFIR. Specific force integrating receiver.

SHA. Software Hazard Analysis.

SHEAR PIN. A pin designed to fail before overstressing of composite parts or overloading of equipment occurs.

SHIPPING HAZARD AREA. An area where the probability of a hit on a ship is unreasonably high.

SHIELD. A metallic barrier that completely encloses a device for the purpose of preventing or reducing induced energy.

SOFT TREE. A fault tree which is constructed on a system which includes software interfacing with hardware. A software fault tree.

SOFTWARE. Computer programs, procedures, rules, and possibly associated documentation and data pertaining to the operation of a computer system. See also application software, system software.

SOFTWARE DEVELOPMENT PROCESS. The process by which user needs are translated into software requirements, software requirements are transformed into design, the design is implemented in code, and the code is tested, documented, and certified for operational use.

SOFTWARE ERROR. An occurrence, during the execution of a program, attributable to software which fails to satisfy the program performance specifications or fails to perform as designed.

SOFTWARE REQUIREMENTS. Tasks required of a computer(s) to enable the interfacing hardware to perform its intended function.

SOFTWARE SAFETY. The application of system safety engineering techniques to software in order to ensure and verify that the software design takes positive measures to enhance system safety and that errors which could reduce system safety have been eliminated or controlled.

SOFTWARE SAFETY ANALYSIS. An analysis of the software of a system element to identify and eliminate software errors, faults, or deficiencies relating to safety critical command and control functions.

SLC. Space launch complex.

S/N. Signal to noise.

SOP. Standard operating procedure.

SPA. Storage plate assembly.

SPECIFICATION. A document that prescribes, in a complete, precise, verifiable manner, the requirements, design, behavior, or other characteristics of a system or system component.

SPL - SINGLE-PROPELLANT LOADING. A propellant loading or unloading operation involving transfer of only one propellant when the other propellant is not aboard.

SRM. Solid rocket motor.

SRT. System readiness testing.

SSG. Systems safety group.

SSPP. Systems safety program plan.

STABLIZATION TIME. The initial warm-up time required by the transponder in order to perform within required operating specifications.

STANDARD STATISTICAL TEST PROCEDURES. Bruceton or Probit statistical tests.

STATIC FIRING. Firing an anchored vehicle engine without intent for flight.

STRUCTURAL MEMBER. Any structure or load carrying intergral part of a track.

SUBROUTINE. A subprogram that is invoked by a calling statement that may or may not receive input values, and that returns any output values through parameter names, program variables, or mechanisms other than the subroutine name itself. Contrast with function.

SYSTEM. A collection of people, machines, and methods organized to accomplish a set of specific functions.

SYSTEM SOFTWARE. Software designed for a specific computer system or family of computer systems to facilitate the operation and maintenance of the computer system and associated programs; for example, operating systems, compilers, utilities.

TESTABILITY. Programs are simply structured and use general algorithms to facilitate step-by-step testing of all capabilities.

TFE. Polytetraflouroethylene.

TI. Technical interchange.

TLV. Threshold limit value.

TM. Telemetry.

TMFE. Telemetry front-end equipment.

TMIG. Telemetry inertial guidance.

T-0. Missile lift-off time.

TNSE. Technical Nuclear Safety Evaluation.

TO. Technical order.

TOCC. Test operation control center.

TRACKING AID. A beacon or transponder in the vehicle designed to aid in establishing its position.

TRANSMITTER FREQUENCY. The frequency of maximum RF energy within the transponder reply pulse radiation spectrum.

TRANSPONDER RECOVERY TIME. The minimum time interval between interrogation pulses or code groups required for transponder normal response to interrogation signal levels within its dynamic range.

TSP. Test safety procedure.

TT. Thrust termination.

USCG. United States Coast Guard.

USEABILITY. Programs have functions and usage techniques that are natural and convenient for people and show good consideration of human factors and limitations. For example, the programs have few arbitrary codes for data input or output, have consistent conventions in different operating modes and provide thorough diagnostic messages for errors or violations of use.

VAFB. Vandenberg Air Force Base.

VALIDITY. Programs provide the performance, all functions and appropriate interfaces to other software components that are sufficient for beneficial application in the intended user environment. This means that the software, without additional programming or manual intervention, has the capabilities that reasonably would be expected for its purpose. Validity is a quality of specifications as well as computer programs. Examples of an invalid program would be an interactive editor that had no on-line function for retrieving stored text for inspection or a FORTRAN language compiler that had no DO LOOP implementation. Validity involves judgement of user requirements and may change if the intended application or purpose is altered. Because poor reliability may render a needed function useless, reliability is necessary to validity.

VDC. Volts direct current.

VECO. Vernier engine cutoff.

VIPS. Vandenberg impact prediction system.

Vrms. Volts root mean square.

VSWR. Voltage standing wave ratio.

WDR. Wet dress rehearsal.

WAIVER. Granted use or acceptance of an article that does not meet the specified requirements.

WCOOA. West Coast Offshore Operating Area.

WINDS. Weather information network display system.

WSMC. Western Space and Missile Center.

WSS. Wire skyscreen.

WTR. Western Test Range.

1 STRAD. 1st Strategic Aerospace Division.

REFERENCE MATERIALS

Government documents and appropriate publications from other sources considered relevant to this regulation. Latest revisions should be used unless otherwise indicated.

1. Air Force Publications.

AFR 11-4	- Host-Tenant Support Responsibilities of USAF Organizations
AFR 19-2	- Environmental Impact Analysis Pocess, (EIAP)
AFR 55-34	- Reducing Flight Disturbances
AFR 71-4	Preparation of Hazardous Materials for Military Air Shipment
AFR 80-14	- Test and Evaluation
AFP 85-1	- Electrical Facilities Safe Practices Handbook
AFM 88 Series	- Facility Design and Planning
AFM 91-13	- Maintenance of Permanently Installed Storage and Dispensing System for Unconventional AFR Fuels.
AFR 91-28	- Permanently Installed Storage and Dispensing Systems for Petroleum and Unconventional Fuels
AFR 92-1	- Fire Protection Program
AFR 100-6	- Electromagnetic Interference and Radiation Hazards
AFR 122-15	- Nuclear Power System Safety Reviews and Surveys
AFR 122-16	- Nuclear Safety Review Procedures for Space or Missile Use of Minor Radioactive Sources
AFR 127-4	- Investigating and Reporting US Air Force Mishaps
AFR 127-12	- Air Force Occupational Safety and Health Program (PA)
AFR 127-100	- Explosive Safety Standards
AFR 136-6	(S) Command Disable System (CDS) (U)
AFR 136-10	- Air Force Explosive Ordnance Disposal Program
AFR 160-24	- Standards for Blood Banks and Transfusion Services
AFR 160-32	- Clinical Laboratory Classification and Capabilities
AFR 161-1	- Control of Vector Borne Diseases
AFR 161-2	- Aerospace Systems Management-Medical

AFR 161-6	- Control of Communicable Diseases
AFR 161-8	- Control and Recording Procedures-Occupational Exposure to Ionizing Radiation
AFR 161-11	- Cold Injury
AFR 161-16	- Radioactive Material Licenses and Permits
AFM 161-30	- Chemical Rocket/Propellant Hazards
AFM 161-30, Vol 1	- Solid Rocket/Propellants
AFM 161-30, Vol 2	- Liquid Propellants
AFR 161-35	- Hazardous Noise Exposure
AFR 207-24	- (S) System Security Standard - Space Launch Complexes (U)
AFR 800-14, Vol 2	- Acquisition and Support Procedures for Computer Resources in Systems
AFR 800-15, SD Sup 1	- Human Factors Engineering and Management
AFR 800-16	- USAF System Safety Programs

2. Air Force Occupational Safety and Health Standards (AFOSH STD).

AFOSH STD 127-1	- Walking Surfaces
AFOSH STD 127-2	- Guarding Floor and Wall Openings/Holes
AFOSH STD 127-3	- Fixed Industrial Stairs
AFOSH STD 127-6	- Fixed Ladders
AFOSH STD 127-7	- Scaffolding
AFOSH STD 127-9	- Manually Propelled and Self-Propelled Mobile Work Platforms and Scaffolds (Towers)
AFOSH STD 127-11	- Electrical Installations and Equipment
AFOSH STD 127-31	- Personal Protective Clothing and Equipment
AFOSH STD 127-38	- Hydrocarbon Fuels General
AFOSH STD 127-39	- Fuel Servicing Operations

AFOSH STD 127-40	- Fuel Storage Systems
AFOSH STD 127-59	- Dry Chemical Installed Fire Extinguishing Systems
AFOSH STD 127-60	- Carbon Dioxide Installed Fire Extinguishing Systems
AFOSH STD 127-62	- Standpipe and Hose Systems
AFOSH STD 127-63	- Fire Alarm and Detection Systems
AFOSH STD 127-66	- General Industrial Operations
AFOSH STD 161-1	- Respiratory Protection Program
AFOSH STD 161-8	- Permissible Exposure Limits for Chemical Substances
AFOSH STD 161-9	- Exposure to Radiofrequency Radiation
AFOSH STD 161-10	- Health Hazards Control for Laser Radiation
AFOSH STD 161-13	- Exposure to Hydrazine

3. American National Standards Institute Publications.

ANSI A10.4	- Safety Requirements for Personnel's Hoist
ANSI A12.1	- Safety Requirements for Floor and Wall Openings, Railings, and Toe Boards
ANSI A13.1	- Scheme for the Identification of Piping Systems
ANSI A14.3	- Safety Requirements for Fixed Ladders
ANSI A17.1	- Safety Code for Elevators and Escalators
ANSI A17.2	- Practice for the Inspection of Elevators, Escalators and Moving Walks (including A17.2a)
ANSI A58.1	- Building Code Requirements for Minimum Design Loads for Buildings and Other Structures
ANSI A90.1	- Safety Standard for Manlifts
ANSI A117.1	- Specifications for Making Buildings and Facilities Accessible to and Usable by Physically Handicapped People
ANSI B19.3	- Safety Standard for Compressors for Process Industries
ANSI B30.1	- Jacks
ANSI B30.2	- Overhead and Gantry Cranes (Top Running Bridge Multiple Girder)

ANSI B30.9	- Slings
ANSI B30.10	- Hooks
ANSI B30.11	- Monorail and Underhung Cranes
ANSI B30.16	- Overhead Hoists
ANSI B31.1	- Power Piping, (including Addendment B31.1a and B31.1b)
ANSI B56.1	- Low Lift and High Lift Trucks
ANSI B57.1	- Compressed Gas Cylinder Valve Outlet and Inlet Connections
ANSI C2.2	- Safety Rules for the Installation and Maintenance of Electrical Supply and Communication Lines (NBS H81)
ANSI C39.5	- Safety Requirements for Electrical and Electronic Measuring and Controlling Instrumentation
ANSI C95.1	- Safety Rules with respect to Human Exposure to Radio Electromagnetic Fields
ANSI D7.1	- Inspection Procedures for Motor Vehicles, Trailers, and Semitrailers Operated on Public Highways
ANSI K13.1	- Identification of Air-Purifying Respirator Canisters and Cartridges
ANSI Z9.1	- Practices for Ventilation and Operation of Open-Surface Tanks
ANSI Z9.2	- Fundamentals Governing the Design and Operation of Local Exhaust Systems
ANSI Z9.3	- Safety Code for the Design, Construction and Ventilation of Spray Finishing Operations

4. Code of Federal Regulations.

CFR Title 10	- Energy
CFR Title 29	- Labor (OSHA)
CFR Title 49	- Transportation

5. Crane Manufacturers Association of America Specifications.

CMAA 70	- Electric Overhead Cranes
CMAA 74	- Monorails

6. Air Force System Command (AFSC) Design Handbooks.

DH 1-3	- Human Factors Engineering
DH 1-6	- System Safety
DH 3-3	- Ground Equipment and Facilities

7. Data Item Descriptions.

DI-H-7047	- Systems Safety Program Plan
DI-S-30564	- Radiological Safety Analysis Summary and Radiation Protection Plan
DI-S-30565A	- Accident Risk Assessment Report

8. Department of Defense Publications.

DODD 3200.11	- Use, Management and Operations of Department of Defense Major Ranges and Test Facilities
DODM 4145-26	- DOD Contractors Safety Manual for Ammunition, Explosives, and Related Dangerous Materials
DODM 4270-1	- DOD Construction Criteria Manual (X-Limited to Hq USAF only)
DODS 6055-9	- DOD Ammunition and Explosives Safety Standard (X-S&I, AFISC/SEV, Norton AFB CA 92409)

9. 1st Strategic Aerospace Division Publications.

1 STRADR 80-1	- ICBM Operational Test and Evaluation (FOUO) (S&I by OPR) (1 STRAD/DOC)
1 STRADR 127-200	- Missile Mishap Prevention

10. General Orders, California Public Utility Commission.

G.O. 95	- Rules for Overhead Line Construction
G.O. 128	- Rules for Construction of Underground Electric Supply and Communication Systems

11. Military Specifications and Standards.

DOD-STD-480A	- Configuration Control - Engineering Changes, Deviations and Waivers
DOD-STD-1679A	- Military Standards for Software Development
MIL-B-5087B	- Bonding, Electrical and Lightning Protection for Aerospace Systems

MIL-B-7883B	- Brazing of Steels, Copper, Copper Alloys, Nickel Alloys, Aluminum and Aluminum Alloys
MIL-E-4158E	- General Requirements for Electronic Equipment Ground
MIL-H-46855	- Human Engineering Requirements for Military Systems, Equipment and Facilities
MIL-HDBK-5C	- Metallic Materials and Elements for Aerospace Vehicle Structures
MIL-M-8090F	- General Requirements for Mobility, Towed Aerospace Ground Equipment
MIL-P-5518C	- Pnuematic Systems, Aircraft, Design, Installation, and Data Requirements for Supplement 1
MIL-Q-9858A	- Quality Program Requirements
MIL-S-52779	- Software Quality Assurance Program Requirements
MIL-STD-101B	- Color Code for Pipelines and for Compressed Gas Cylinders
MIL-STD-172B	- Color Code for Containers of Liquid Propellants
MIL-STD-454H	- Standard General Requirements for Electronic Equipment
MIL-STD-461B	- Electromagnetic Emission and Susceptibility Requirements for the Control of Electro-magnetic Interference
MIL-STD-462	- Measurement of Electromagnetic Interference Characteristics
MIL-STD-483	- Configuration Management Practices for Systems, Equipments, Munitions and Computer Programs
MIL-STD-490	- Specification Practices
MIL-STD-721	- Definition of Effectiveness Terms for Reliability, Main- - tainability, Human Factors and Safety
MIL-STD-785B	- Reliability Program for Systems and Equipment Development and Production
MIL-STD-826A	- Test Electromagnetic Interference Test Requirements and Test Methods
MIL-STD-882B	- System Safety Program Requirements
MIL-STD-962	- Outline of Forms and Instruction for the Preparation of Military Standards and Military Handbooks
MIL-STD-965	- Parts Control Program
MIL-STD-1247B	- Marking, Functions and Hazards Designations of Hose, Pipe and Tube Lines for Aircraft, Missile and Space Systems

MIL-STD-1385	- General Requirements for Preclusion of Ordnance Hazards in Electromagnetic Fields
MIL-STD-1472C	- Human Engineering Design Criteria for Military Systems, Equipment and Facilities
MIL-STD-1512	- Design Requirement and Test Methods ElectroExplosive Subsystems Electrically Initiated Subsystems
MIL-STD-1521	- Technical Reviews and Audits for Systems, Equipment and Computer Programs
MIL-STD-1522	- Standard General Requirements for Safe Design and Operation of Pressurized Missile and Space Systems
MIL-STD-1540A	- Test Requirements for Space Vehicles
MIL-STD-1541	- Electromagnetic Compatibility Requirements for Space Systems
MIL-STD-1542	- Electromagnetic Compatibility (EMC) and Grounding Requirements for Space Systems Facilities
MIL-STD-1543	- Reliability Program Requirements for Space and Missile Systems
MIL-STD-1546	- Parts, Materials, and Processes Standardization, Control and Management Program for Spacecraft and Launch Vehicles
MIL-STD-1547	- Technical Requirements for Parts, Materials, and Processes for Space and Launch Vehicles
MIL-STD-1574A	- System Safety Program for Space and Missile Systems
MIL-STD-1644	- Trainer System Software Engineering Requirements
MIL-STD-1679	- Weapon System Software Development
MIL-STD-45662	- Calibration System Requirements
MIL-T-21578A	- Basic Requirements for installed Test Equipment, Hazardous Locations
MIL-T-28800B	- General Specification for Test Equipment for Use With Electrical and Electronic Equipment
MIL-W-5088H	- Wiring, Aerospace Vehicle
MIL-W-81600	- Specifications for Installation of Wiring, Guided Missiles

12. National Bureau of Standard Handbooks.

NBSH 66	- Safe Design and Use of Industrial Beta-Ray Sources
NBSH 114	- General Safety Standards for Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies Up to 10 MeV

13. National Electrical Manufacturers Association (NEMA) Publications.

MG-1	- Motors and Generators
SG-2	- High Voltage Fuses
SG-3	- Low Voltage Power Circuit Breakers
SG-6	- Power Switching Equipment
ST-20	- Dry-Type Transformers for General Applications
TR-1	- Transformers, Regulators and Reactors

14. National Fire Prevention Association Publications.

NFPA 10	- Standards for Portable Fire Extinguishers
NFPA 12	- Standards for Carbon Dioxide Systems
NFPA 30	- Flammable and Combustible Liquids Code
NFPA 31	- Standards for Installation of Oil Burning Equipment
NFPA 50	- Standards for Bulk Oxygen Systems at Consumer Sites
NFPA 50A	- Standards of Gaseous Hydrogen Systems at Consumer Sites
NFPA 50B	- Standards for Liquid Hydrogen Systems at Consumer Sites
NFPA 54	- National Fuel Gas Code
NFPA 58	- Standards for Storage and Handling of Liquified Petroleum Gases
NFPA 70	- National Electrical Code
NFPA 78	- Lightning Protection Code
NFPA 91	- Standards for Installation of Blower and Exhaust Systems of Dust, Stock and Vapor Removal or Conveying
NFPA 101	- Code for Safety to Life from Fire in Buildings and Structures
NFPA 252	- Standard Methods of Fire Tests Door Assemblies
NFPA 255	- Method Test of Surface Burning Building Characteristics
NFPA 257	- Standards for Fire Tests of Window Assemblies
NFPA 493	- Apparatus for use in Division One Hazardous Locations

15. Occupational Safety and Health Administration Rules.

OSHA 1910.109	- Explosives and Blasting Agents
OSHA 1910.133	- Eye and Face Protection
OSHA 1910.184	- Slings

16. Air Force Technical Orders.

TO 00-110N-2	- Radioactive Waste Disposal
TO 00-110N-3	- Requisition Handling, Storage and Identification of Radioactive Materials
TO 00-25-223	- Integrated Pressure Systems and Components (Portable and Installed)
TO 00-25-224	- Welding High Pressure and Cryogenic Systems
TO 00-25-229	- Valves and Regulator Criteria for Integrated Pressure Systems (Portable and Installed)
TO 00-25-232	- Control and Use of Insulation Knitting for High Voltage Application
TO 00-25-234	- General Shop Practice Requirements for the Repair, Maintenance and Test of Electronic Equipment (Philco Corp)
TO 00-25-235	- Safety Procedures and Equipment of Confined Space Entry (Including Missile Propellant Tanks)
TO 11A-1-42	- General Instructions for Disposal of Conventional Munitions
TO 11A-1-47	- Explosives Hazard Classification Procedures
TO 14P3-11-1	- Protective Clothing for Handlers of Missile Fuels and Oxidizers
TO 14P3-11-21	- Rocket Fuel Handlers' Coveralls, Gralite Jacket, Self Ventilating Hood
TO 31A-10-4	- AF Comm. Service SVC (E-1 STD) Standard Installation Practices, Delta Matched Doublet Antenna
TO 31Z-10-4	- Electromagnetic Radiation Hazards
TO 36-1-58	- General Requirements for Repair Maintenance and Testing of Lifting Devices
TO 42B5-1-2	- Use, Handling and Maintenance Instructions Storage Type Gas Cylinders
TO 42B7-2-1-3	- Quality Control of Propellant Nitrogen Tetroxide

TO 42B7-2-1-4	- Quality Control of Propellant Hydrazine, Unsymetrical Dimethylhydrazine (50/50) mixture
TO 42B7-3-1-1	- Quality Control of Liquid Nitrogen
TO 42B7-3-1-2	- Quality Control of Helium Propellant Pressurizing Agent
TO 42C-1-11	- Cleanliness Standards, Cleaning and Inspection Procedures for Ballistic Missile Systems

17. Underwriter's Laboratories, Inc.

UL 555	- Fire Dampers and Ceiling Dampers
UL 674	- Electric Motors and Generators for use in Hazardous Locations, Class I, Group C & D; Class II, Group E, F & G

18. Vandenberg AFB Regulations.

VAFBR 92-1	- Fire Prevention (S&I by OPR) (4392AEROSG/DEF)
VAFBR 136-1	- Storage, Handling and Inspection of Contractor and Tenant Explosives on Vandenberg Air Force Base
VAFBR 161-1	- Control of Ionizing Radiation

19. WSMC Publications.

Range Users Handbook

WSMCR 55-7	- Aircraft and Aeronautical System Testing on the WCOOA
WSMCR 100-1	- Radio Frequency Management
WSMCR 127-2, Vol. II	- Launch Complex Safety Operating Procedures (LCSOP)

20. Documents useful in preparing data required by chapter 4:

ETMWG Document 103-80	- IRIG Standard for Pulse Repetition Frequencies and Reference Oscillator Frequency for C-Band Radars
ETMWG Document 111-65	- IRIG Standard Coordinate System and Data Format for Antenna Patterns
ETMWG Document 114-69	- IRIG Pulse Doppler and Coherent Radar Standards
ETMWG Document 115-69	- Non-Coherent C-Band Transponder Standards
FCWG Document 101-65	- Frequency Standards for Radar Beacons

IRIG Document 106-59	- IRIG System Standards for C-Band (5CM) Instrumentation Radars and Beacons
RCC Document 502-81	- A Glossary of Range Terminology
RCCRSG Document 306-78	- Flight Termination Receiver Catalog
RCCRSG Document 307-79	- Range Safety Transmitting System 6-549 MHz Band
RCCRSG Document 308-79	- Range Safety Transponder Catalog
RCCRSG Document 310-79	- Test Procedure for C-Band Noncoherent Radar Transponder
RCCRSG Document 313-80	- Flight Termination Receiver Decoder Design, Performance, and Certification
WSMC Technical Report TR-65-1	- Power Transfer between Two Antennae with Special Reference to Polarization

Western Test Range Geodetic Coordinates Manual, Part I, (OPR: ROIS)

NOTE: These IRIG documents may be obtained from:

Secretariat, Range Commanders Council
ATTN: STEWS-SA-R
White Sands Missile Range, NM 88002

21. Miscellaneous Publications.

AASHTO H20	- American Association of State Highway and Transportation Officials
ADC 1062R3	- Air Diffusion Council, Equipment Test Code
AFSCR 127-6	- Air Force Systems Command Regulations, System Safety Groups
AFSCR 800-15	- Human Factors Engineering and Management
AFSCM 80-12	- AFSC Standard Theoretical Trajectory Magnetic Tape Format
AISC	- American Institute of Steel Contruction, Specification for Design, Fabrication and Erection of Structural Steel Buildings
ASHRAE	- American Society of Heating, Refrigeration, and Air Conditioning Engineering
CALOSHA Title 8	- State of California Administration Code for Industrial Relations
CG 108	- Coast Guard Regulation Rules and Regulations for Military Explosives and Hazardous Munitions
CPIA, Vol I	- Chemical Propulsion Information Agency

D2-26240-1	- The Boeing Co., Minuteman I Re-Entry Systems Launch Program Handbook for Payload Designers
IEEE-STD-729	- IEEE Standard Glossary of Software Engineering Terminology
IES	- Illuminating Engineering Society Lightning Handbook
SHB-S-100	- Payload Ground Safety Handbook
National Aeronautics and Space Council Document	- Nuclear Safety Review and Approval Procedures for Minor Radioactive Sources in Space Operations
NHB 1700.7A	- NASA Handbook - Safety Policy and Requirements for Payloads Using the Space Shuttle System
NAVORD Instruction 8020.3	- Navigational Order, Hazard Classification Procedure
SDR 127-8	- System Safety Engineering
SD STD-73-3	- Computer Software Design and Development, Standard Engineering, Practices for
SD STD 79-1	- Integrated System Safety Program for the M-X Weapon System
Sec. Def. Multi-Addressee Memo	- Policy on Safety Associated with Earth Recovery of Satellites and Deep Space Vehicles
ASME Standard	- American Society of Mechanical Engineers Boiler and Pressure Vessel Code, 1955, SEC VIII, Unfired Press, Vessels and Alternate Rules for Press. Vessels, Div 2, 1968 Sec VIII, Boiler and Pressure Vessel Code
SAMTOR 80-4	- Missile Antenna Data Requirements

SOFTWARE SYSTEM DESIGN REQUIREMENTS

1. Purpose. This guideline is provided as a ready reference for anyone designing or creating software for use with any missile or space vehicle which will be launched from Vandenberg AFB CA. This includes any associated ground support facilities or equipment.

2. Scope. Unless specifically excluded, all computer software (including that associated with embedded computers/computer systems and test equipment) used to control or monitor safety critical ground or flight sequences, functions or processes shall be designed in accordance with this document. EXCEPTION: All computer hardware and software procured by WSMC/RQ for use by the Western Test Range (WTR) is exempt from the requirements of this attachment. WSMC/RQ ensures validity and safety of WTR procured computer equipment.

3. Philosophy. It is recognized that the use of computer systems to control and monitor critical functions will continue to proliferate as systems become more and more complex. This is inevitable and not, in itself, undesirable. It is also recognized, however, that as software controlled systems become more complex the potential hazards introduced with the software also increase. Although software does not "fail" as such, it can be "faulty" or "error" prone. The usual causes of "faulty" software are: a) incomplete or incorrect software requirements; b) incorrect software code; c) insufficient software testing; d) incompatibility with hardware; e) poorly designed, confusing, or non-standard user-system interfaces which are incompatible with or "unfriendly" toward the user-operator. Although it is probably impossible to make all software 100 percent error free, strict adherence to the principles and practices spelled out in these design requirements will go far toward ensuring software safety.

4. Checklist:

4.1. The system software shall possess the following general properties characteristic of high quality software: correctness, reliability, validity, resilience, useability, clarity, maintainability, testability, modifiability, generality, efficiency and economy.

4.2. Any single CPU controlling a process which could result in major system loss, system damage or loss of human life shall be incapable of satisfying all the requirements for initiation of the process.

4.3. A status check of critical system elements shall be made prior to executing a potentially hazardous sequence.

4.4. Upon completion of a test where safety interlocks were removed, the restoration of those interlocks shall be verified.

4.5. Critical data communicated from one CPU to another shall successfully pass a data verification check.

4.6. The results of critical algorithms shall be verified prior to use. The software shall verify safety critical parameters or variables before an output is allowed. Parity or other checks shall require two decisions before output.

4.7. Program design and code shall be structured to enhance comprehension of program logic.

4.8. Program design and code shall be modular in an effort to reduce logic errors and improve logic error detection and correction functions.

4.9. Hazardous processes requiring critical timing shall be automated.

4.10. When software generates a hardware command, an analysis shall be performed to determine if the command should be continuous until reversed or only used for a discrete length of time.

4.11. The software shall require an operator response for initiation of any potentially hazardous sequence.

4.12. Decision logic using registers which obtain values from end-item hardware and software shall not be based on values of all "ones" or all "zeros."

4.13. Decision logic using registers which obtain values from end-item hardware and software shall require a specific binary pattern to reduce the likelihood of malfunctioning end-item hardware/software satisfying the decision logic.

4.14. Operations employing time limits impacting system safety shall have these time limits included in the logic.

4.15. The safety critical time limits in logic shall not be changeable by the operator from the console.

4.16. The software system shall respond to pre-defined anomalous conditions by notifying the operator of the condition.

4.17. Upon detection of a predefined safety critical anomaly, the system shall revert to a known safe configuration.

4.18. Upon detection of a predefined safety critical anomaly, the software shall inform the operator what anomaly was detected.

4.19. Upon detection of a predefined safety critical anomaly, the software shall inform the operator what action was taken.

4.20. Upon safing the system, the software shall identify the resulting system configuration or status to the operator and await definition of subsequent software activity.

4.21. Workaround procedures shall not be allowed when reverting to a safe configuration after the detection of an anomaly.

4.22. Safing scenarios for safety critical hardware items shall be designed into the logic.

4.23. All safing requirements shall be detailed in the software design specifications.

4.24. Operator interactions with the software shall be concise.

4.25. The software shall provide for detection of improper sequence requests by the operator.

4.26. The software shall provide for notification of improper keyboard entries by the operator.

4.27. The software shall not allow a hazardous sequence to be initiated by a single keyboard entry.

4.28. The software system shall protect against unauthorized access.

4.29. The software shall provide for operator cancellation of current processing.

4.30. Operator cancellation of current processing shall require a single operator response.

4.31. Cancellation of processing shall be accomplished in a safe manner.

4.32. Any override of a safety interlock shall be identified to the test conductor via display on the test conductor's CRT.

4.33. Software controlled sequences affecting safety shall require a minimum of two independent procedures for initiation.

4.34. The software shall be developed such that inadvertent instruction jumps are detected and protected against. The system shall provide for a fail-safe recovery from inadvertent instruction jumps which could result in a hazardous condition.

4.35. The software shall discriminate between false and valid interrupts.

4.36. The computer system shall be immune to the effects of temporary power irregularities.

4.37. The computer system shall be sufficiently protected against the harmful effects of electromagnetic interference.

4.38. Software shall be developed to safely handle contingencies.

4.39. Separate "ARM" and "EXECUTE" commands shall be required for ordnance initiation.

4.40. Interrupt priorities and responses shall be specifically defined.

4.41. Interrupt priorities and responses shall be specifically documented.

4.42. The software shall be initialized to a known state.

4.43. There shall be provisions to protect the accessability of memory regions dedicated to critical functions.

4.44. There shall be periodic memory integrity checks.

4.45. Unless specifically exempted, input/output ports shall not be used for both critical and non-critical functions.

4.46. Critical input/output ports shall have addresses sufficiently different from non-critical ports that a single address bit failure will not allow access to critical functions or ports.

4.47. Software programs shall be designed in a hierarchical manner where the levels of the hierarchy correspond to levels of control of the tasks performed by the program.

4.48. The components of a hierarchical program shall be closed subprograms, or the equivalent, of a size which can be reasonably comprehended and viewed.

4.49. Subprograms that are called from only one point or that operate upon the same data at each call shall be unparameterized.

4.50. Subprograms that operate on different data with different calls shall be parameterized.

4.51. Validity checking by the components of a hierarchical program shall also be arranged hierarchically - gross checking being done at the higher levels and detailed checking at the lower levels.

4.52. Critical subroutines and subprograms shall include a "come from" check to ensure that they are being called from a valid calling program. This usually involves the calling program setting a validity code or flag and the subroutine checking the code prior to taking any safety critical action. If an error, such as an illegal entry into the subroutine, is detected, a "jump" to a specific safety or error handling routine should be made rather than a "return" to the calling routine.

4.53. It shall not be the responsibility of a lower level component to check the validity of the data or parameters provided to it by a higher level component.

4.54. The structure of programs that process hierarchically organized files shall reflect the file structure.

4.55. Program components shall be programmed in execution order; that is, components at the higher levels in the hierarchical program organization shall be programmed before components at the lower levels. (Calling routines shall be programmed before called routines.)

4.56. Dummy called routines may be employed in early checkout; dummy calling routines are NOT permitted.

4.57. When a routine is programmed, it shall be programmed to comply with an interface that has already been programmed.

4.58. When a routine is programmed, it shall always be possible to check it out with the components at higher levels in the hierarchy.

4.59. Logic shall be standardized in such a manner as to enhance the readability of programs and to eliminate intricate logic that is difficult to validate and verify.

4.60. Software should be designed and shall be coded using only the five basic control structures presented in Figures A3-1.1 - A3-1.5. They are: the SEQUENCE of Operations (assignment, add,. . .), IF THEN ELSE (conditional branch to one of two operations and return), DO WHILE (operation repeated while a condition is true), DO UNTIL (operation repeated until a condition is true), and CASE (operation which provides the transfer of program control to a specific location within a compile-time system).

4.61. The readability and communicability of program routines shall be enhanced by restricting their size to that which can be easily viewed and comprehended. The maximum size of a set of instructions which may be called shall be fifty (50) lines of instructions unless otherwise approved by WSMC/SE in conjunction with the procuring authority.

4.62. Application software that affects the system's operation consoles shall provide for:

4.62.1. Operator visibility.

4.62.2. Positive manual control.

4.62.3. Support of testing with software that executes test sequences with minimal operator input.

4.62.4. Automatic fault isolation/notification and correction, where applicable.

4.63. The software system shall make reasonable checks on all safety critical inputs.

4.64. The software system shall display safety critical timing data to the operator.

4.65. The software system design shall conform to MIL-STD-1472 with regard to display color usage.

4.66. The software system shall manage interrupt control so as not to compromise safety critical operations by:

4.66.1. Providing, as a minimum, a two step operator request to resolve safety critical interrupt limits.

4.66.2. Providing, as a minimum, a two step operator request to initiate or terminate any function called into execution by the operator.

4.67. In the event of system console failure, the software system shall ensure:

4.67.1. The continuance of processing according to operational requirements (by implementing orderly shutdown and hold, transferring control to a backup console, or continuing to operate if coordinated with and approved by WSMC/SE).

4.67.2. The software portions of the system are not allowed to remain in a predefined hazardous configuration.

4.68. The software system shall provide status of applicable system health and data validity in displays.

4.69. The software system shall verify the existance of prerequisite conditions prior to command issuance in accordance with pre-defined operational requirements.

4.70. The software system shall indicate to the operator the operation(s) and functions(s) currently active.

4.71. The software system shall identify to the operator that safing function execution has occurred and provide the reason for the execution and a description of the safing action taken.

4.72. All application software sets shall use standard INTER system and INTRA system communication techniques which are compatible with the total automation approach.

4.73. The software structure shall allow the adding of interfaces within a system, or between systems, and the single control point without requiring changes to architecture.

4.74. An application software set shall provide manual command capability of all commandable critical system components through the use of display programs.

4.75. An application software set shall not be dependent upon keyboard commands other than to initially perform the level one program which activates all concurrencies for the application set. All subsequent keyboard interfaces shall be to currently executing application set software.

4.76. The software structure shall be standard and allow for additions, deletions, and modifications of software modules to accommodate requirement changes with no adverse impact to the safety of the system and with minimal impact to the software application set. In particular, changes shall not affect timing, the interrupt priority system or the interdependence of modules/data.

4.77. The application software set shall initiate an emergency mode operator request within five (5) seconds even if a previous nonemergency request is in progress. System safing is an emergency mode operation.

4.78. An application software set shall provide fault tolerance capability (for example, through redundant sensors or measurements, voting routines and multiple command issuance) for commands and measurements such that individual commands that fail to operate normally or individual measurements that contain incorrect or out-of-tolerance data may be bypassed or ignored.

4.79. An application software set shall ensure proper configuration of inhibits, interlocks, safing logic, and exception limits at initialization.

.80. Each application software set shall determine and maintain the status of its system and environment upon initialization and during operation.

4.81. An application software set shall detect failures within the computer system elements and perform system monitoring and control through backup or redundant paths when primary sources fail. An application software set shall use redundant measurement voting when possible.

4.82. Each application set shall provide the capability for automatic fault detection, problem isolation and automatic recovery. This capability shall be provided based upon the availability of system data to define a fault isolation plan and where predictable fault sequences and correction can be accomodated. This capability will minimize the requirements for operator intervention when critical anomalies occur.

4.83. Application software sets shall display, via the CRT, fault occurrences and corrective action taken.

4.84. To ensure that the current status of a system is visible to the operator, an application software set shall provide an overall system display program. The operator should be able to manually select detailed displays of subsystem components from the overall system display.

4.85. Subsystem displays shall be provided to give detailed visibility of all system components.

4.86. The selected display program shall present all conditions requiring operator attention, such as system failures and prompts.

4.87. All display programs shall have a variable delay in the display loop which the operator can change at run time.

4.88. Display programs shall update and refresh all changed data at least once every five (5) seconds when the variable delay is set to its minimum value.

4.89. Programs shall include routine checks and recovery possibilities that are "forgiving" of common user and data errors.

4.90. The software should be developed such that the majority of the safety critical decisions and algorithms are within a single (or few) software development modules.

4.91. If timing is critical, the computer's oscillator shall be checked against an independent time base.

4.92. If a "watch dog" or "babysit" type circuit is implemented, the circuit shall be totally independent of the computer that it monitors and should begin to monitor the computer as soon as possible after computer power-up (the circuit should not be initialized by the computer).

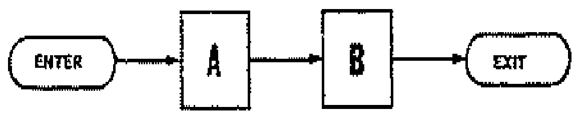
4.93. If it is critical that the computer remain on at all times (for example, for destruct modes, shut down sequences, etc.):

4.93.1. The computer shall be protected against power interrupts, power surges, stray voltages, and gradual depletion of power supplies.

4.93.2. Consideration should be given to connectors and sockets to ensure continuous continuity, especially in high vibration environments.

4.94. Each software module shall have a single entry and single exit structure. (See Fig A3-2).

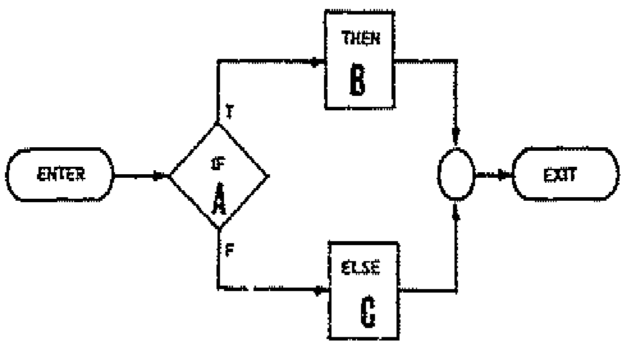
SEQUENCE: Process A, Process B.



Control flows from process A to the next in sequence, Process B.

Figure A3-1.1.

IF THEN ELSE: If condition A THEN process B, ELSE process C.



The flow of control will return to a common point after executing either process B or C. A predicates the conditional execution. If control is to skip a process pending the condition of A, then the flow chart can be modified thusly:

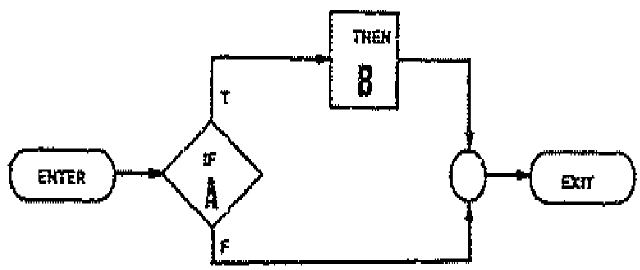
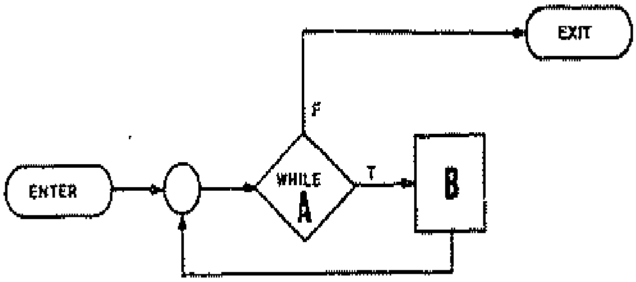


Figure A3-1.2.

Figure A3-1. Control Structures.

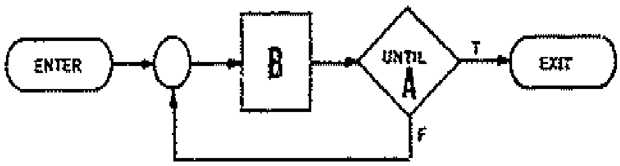
DO WHILE: DO WHILE condition A, process B.



The DO WHILE structure is a loop in which the condition A is evaluated. If found to be true, then control is passed to process B and the condition A is evaluated again. If condition A is false, then control is passed out of the loop.

Figure A3-1.3.

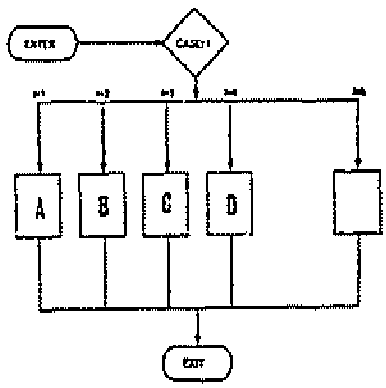
DO UNTIL: DO UNTIL condition A, process B.



The DO UNTIL structure is similar to the DO WHILE -- except that the test of condition A is performed after process B has executed. Thus the DO UNTIL will be performed once regardless of the value of condition A.

Figure A3-1.4.

CASE: Based on CASE conditional i, process i.



Control is passed to process k based on the value of i.

Figure A3-1.5.

Figure A3-1. Control Structures (continued).

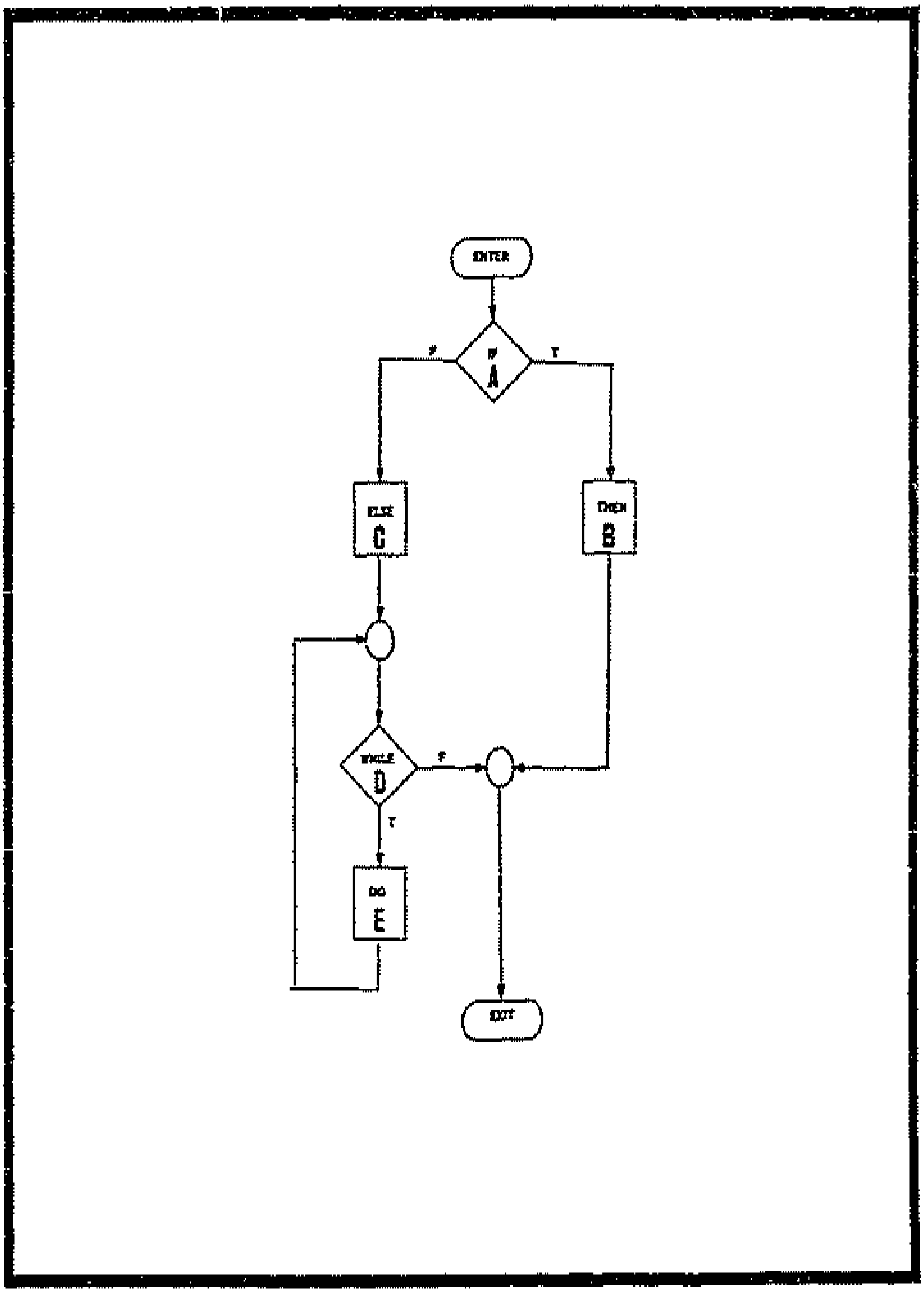


Figure A3-2. Nesting of Control Structures.

FLIGHT TERMINATION COMMAND SYSTEM RF RADIATION CHARACTERISTICS

	SITE 1	SITE 3	SITE 4	SITE 6A	SITE 6B
GEODETIC LATITUDE	34 46 12.1971	34 35 27.0748	37 29 48.7811	34 6 26.8592	34 6 27.1306
GEODETIC LONGITUDE	120 30 22.7504	120 36 43.8591	122 29 55.9235	119 3 57.1449	119 3 57.0067
GEODETIC HEIGHT FEET	767.39	1101.98	62.76	1282.03	1304.87
M.S.L. HEIGHT FEET	890.00	1224.97	176.60	1401.50	1424.34
TRANSMITTER POWER	10 KW	10 KW	10 KW	10 KW	10 KW
GROUND LOSS	1.0 dB	1.0 dB	1.0 dB	1.0 dB	1.0 dB
STEERABLE ANTENNA	YES	YES	YES	YES	YES
TYPE	15 FOOT DISH	15 FOOT DISH	15 FOOT DISH	15 FOOT DISH	15 FOOT DISH
GAIN	23 dBi	23 dBi	23 dBi	23 dBi	23 dBi
POLARIZATION	LEFTHAND CIRCULAR	LEFTHAND CIRCULAR	LEFTHAND CIRCULAR	LEFTHAND CIRCULAR	LEFTHAND CIRCULAR
BEAM WIDTH	10° @ 3 dB	10° @ 3 dB	10° @ 3 dB	10° @ 3 dB	10° @ 3 dB
AXLE RATIO	5 dB	5 dB	5 dB	5 dB	5 dB
SLEW RATE	12°/SECOND	12°/SECOND	10°/SECOND	10°/SECOND	10°/SECOND
AZIMUTH COVERAGE	TOTAL COVERAGE	TOTAL COVERAGE	CW FROM 125° TO 300° TRUE	CW FROM 135° TO 315° TRUE	CW FROM 135° TO 315° TRUE
ELEVATION COVERAGE	+1° TO 90°	+1° TO 90°	+1° TO 90°	+1° TO 90°	+1° TO 90°
POINTING ACCURACY	+1°	+1°	+1°	+1°	+1°
OMNI ANTENNA	YES	YES	NO	NO	NO
GAIN	0 dB	0 dB	N/A	N/A	N/A
POLARIZATION	LEFTHAND CIRCULAR	LEFTHAND CIRCULAR	N/A	N/A	N/A

NOTES:

1. GEODETIC COORDINATES ARE DEPARTMENT OF DEFENSE WORLD GEODETIC SYSTEM 1972.
2. POLARIZATION IS ACCORDING TO IEEE DEFINITION OF SENSE. REFERENCE IEEE TEST PROCEDURE FOR ANTENNAS 149 JAN 65, PAGE 7.

CRANE CATEGORY - FREQUENCY SCHEDULE
FOR OVERHEAD CRANES AND HOISTS

CAT	NOMENCLATURE	FREQUENCY				
		OPER CHECKS	STRUCT MECH/ ELECT CHECKS	ROPE/ HOOK CHECKS	LOAD TEST	HOOK TEST
I	Enclosed Environment Frequent or Daily Use - Critical Loads	D	SA	M	A	A
IA	Enclosed Environment General Use - Critical Loads	P/U	SA	M	A	A
ID	Enclosed Environment Idle 6 Months - Critical Loads	P/U(Q)	SA	P/U(M)	A	A
IC	Enclosed Environment Standby - Critical Loads	P/U(A)	P/U	P/U(M)	A	A
II	Semi-enclosed Environment Frequent or Daily Use - Critical Loads	D	Q	M	A	A
IIA	Semi-enclosed Environment General Use - Critical Loads	P/U	Q	M	A	A
IIB	Semi-enclosed Environment Idle 6 Months - Critical Loads	P/U(Q)	P/U(Q)	P/U(M)	A	A
IIC	Semi-enclosed Environment Standby - Critical Loads	P/U(SA)	P/U	P/U(M)	P/U(1)	P/U(1)
III	Exposed Environment Frequent or Daily Use - Critical Loads	D	M	M	A	A
IIIA	Exposed Environment General Use - Critical Loads	P/U	P/U(M)	M	A	A
IIIB	Exposed Environment Idle 6 Months - Critical Loads	P/U(Q)	P/U(M)	P/U(M)	A	A
IIIC	Exposed Environment Standby - Critical Loads	P/U(Q)	P/U	P/U(M)	P/U(1)	P/U(1)
IV	Enclosed Environment Frequent or Daily Use - Noncritical Loads	D	A	M	BE	A
	Enclosed Environment General Use - Noncritical Loads	P/U	A	M	BE	A
IVB	Enclosed Environment Idle 6 Months - Noncritical Loads	P/U(Q)	A	P/U(M)	BE	A
IVC	Enclosed Environment Standby - Noncritical Loads	P/U(A)	P/U	P/U(M)	P/U(2)	P/U(1)
V	Semi-enclosed Environment Frequent or Daily Use - Noncritical Loads	D	SA	M	BE	A
VA	Semi-enclosed Environment General Use - Noncritical Loads	P/U	SA	M	BE	A
VB	Semi-enclosed Environment Idle 6 Months - Noncritical Loads	P/U(Q)	P/U(6)	P/U(M)	BE	A
VC	Semi-enclosed Environment Standby - Noncritical Loads	P/U(SA)	P/U	P/U(M)	P/U(2)	P/U(1)
VI	Exposed Environment Frequent or Daily Use - Noncritical Loads	D	SA	M	BE	A
VIA	Exposed Environment General Use - Noncritical Loads	P/U	SA	M	BE	A
VIB	Exposed Environment Idle 6 Months - Noncritical Loads	P/U(Q)	P/U(6)	P/U(M)	BE	A
VIC	Exposed Environment Standby - Noncritical Loads	P/U(Q)	P/U	P/U(M)	P/U(2)	P/U(1)

LEGEND

A - Annually
SA - Semi-annually
D - Daily (if used daily, otherwise prior to use
M - Monthly
Q - Quarterly
BE - Be-ennially
P/U - Prior to Use
P/U(1) - Prior to Use if Longer Than 1 Year
P/U(2) - Prior to Use if Longer Than 2 Years
P/U(6) - Prior to Use if Longer than 6 Months
P/U(M) - Prior to Use if Longer Than 1 Month
P/U(Q) - At Least Quarterly and Prior to Use
P/U(SA) - At Least Semi-annually and Prior to Use
P/U(A) - At Least Annually and Prior to Use

Note: If a crane has been secured/mothballed, all checks will be made prior to use.

SCOPE OF CHECKS AND TESTS

Operational Checks:
Operation of all controls, limits and safety circuits, and a running examination of ropes.

Note: The frequencies indicated in the "operational checks" column are binding on the Range contractor only when the Range contractor has sole operating responsibility for the equipment. Under any other operating arrangement, the Range contractor will perform these checks only as a prerequisite to the checks and at the frequencies specified in the "Struct/Mech/Elect Checks" column.

Struct/Mech/Elect Checks:
Complete examination of structure and supports, gears, wheels, bearings, and brakes.

Rope/Hook Checks:
Complete rope inspection for wear, broken wires, diameter reduction and corrosion. Hook inspection for damage and distortion.

Note: On installations with dead-end rope terminations, closely examine the termination to ensure the rope has not slipped in or through its fitting, and that the fitting is not cracked.

Load Tests:
Test initially and following major repairs, alterations, and modifications to 125 percent of rated load and or as otherwise specified in this regulation.

Hook Test:
Test by magnetic particle or other suitable crack detecting process.

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